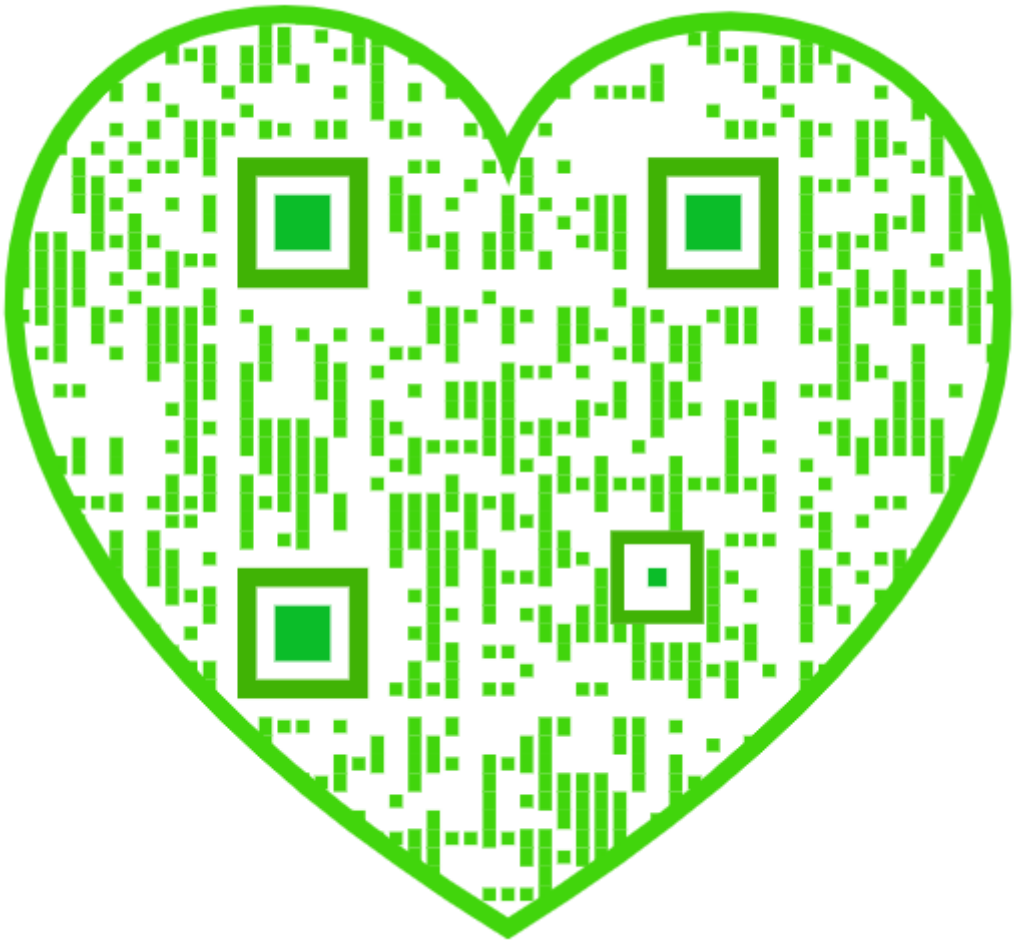

ELEMENTS OF FIELD HYGIENE AND SANITATION

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ELEMENTS

OF

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AND

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APPROVED FOR PUBLICATION BY THE SURGEON GENERAL U. S. ARMY.

WITH 152 ILLUSTRATIONS

PHILADELPHIA

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PREFACE

One of the important subjects with which newly commissioned officers must acquaint themselves is the care of troops. Disease has killed more soldiers than powder and shot, and has occasioned the defeat of many armies.

But when so much other military knowledge must be acquired, a description of how troops are kept healthy should be brief. This booklet, therefore, considers only those points that are of proven value. Many illustrations are employed in order to give clear ideas of the sanitary apparatus used in different armies and to abbreviate the text.

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FIELD HYGIENE AND SANITATION

CHAPTER I

MILITARY HYGIENE AND SANITATION— GENERAL CONSIDERATIONS

Hygiene is both the art and the science of preserving and improving health. It pertains especially to the individual. Sanitation or public hygiene considers both the principles and apparatus employed for the purpose of promoting the health of communities.

The keynote of both hygiene and sanitation first, last, and all the time, is cleanliness,—cleanliness of both mind and body, cleanliness of thoughts and habits, of association and environment; cleanliness of both the exterior and tissues of the body, for the latter should be free from all noxious materials. The essential end of both hygiene and sanitation is to promote cleanliness.

Military hygiene and sanitation consider the parts of these sciences which are of a special value to armies, more particularly when they are in the field. Circumstances then existing are, to a degree, peculiar and peculiar measures must be adopted for the preservation of health. The successful sanitary service of groups of men living close to nature, unprovided with many of those refinements of civilized life developed for static community service, presents problems, often unique, which require prompt and resourceful solution. Congregation of troops in such close contact as exists in camps, facilitates the transmission of disease among them, while exposure to the elements and the privations inseparable from the military service tend to lower their powers of resistance. The prime duty of the Medical Department is not the care of the individual, harsh as they may seem, but the preservation of the health of the command in order that its numbers and vigor may be unimpaired

and its military value thus maintained. The Medical Department seeks to contribute to this end also by such skilful treatment of the sick and wounded as will insure their early return to the firing line. Its medical and surgical service is humanitarian and individual. Its sanitary service, which, from a military standpoint is of greater importance, is utilitarian and collective.

The sanitary service of troops is not an imposition or a necessary evil. It is an effort to assist the commander in preserving the health and thus the number and morale of his troops. It is an essential and integral part of the military organization. Though expensive, sanitary measures are worth more than they cost. Carrell estimates that on a cold business basis each healthy soldier is worth $6000 to the state. A sick soldier is not only useless but requires the services of able-bodied people, is a constant source of expense, perhaps a focus of infection, and later burdens the state through the pension list. The skilled military commander will employ the best sanitary service available and will utilize, if possible, the measures they advocate, doing the best he can for his troops.

Discipline is essential for the proper enforcement of orders affecting health. The sanitary adviser can do nothing if his recommendations are not enforced by the commanding officer. Under similar circumstances the morbidity of those commands whose discipline is lax, is invariably higher than is that of those whose discipline is strict. An increased sick report is only one of the several ways in which the demoralizing effects of lax discipline manifest themselves. Though the sanitary function of the Surgeon ceases with his advice (unless his commanding officer authorizes him to give orders on the subject) he may by tact, reasonableness and clear exposition secure their enforcement when others less circumspect would fail. In the last analysis, however, responsibility for the health of the command rests upon its commanding officer. Experienced line officers appreciate the value of hygiene and sanitation and make every effort to keep their troops in health. They realize that this is a duty which they owe both to the individuals in their commands and to the state. It is obvious that a fully manned vigorous organization can give a better account of itself in battle, for which armies exist, than one whose vigor has been impaired and its ranks depleted by disease. Other things being equal, the relative efficiency of com-

manding officers may be judged with much accuracy by the healthfulness of their respective organizations.

This is all very obvious and trite, but many newly commissioned line officers and newly enlisted men must be educated in the necessity for sanitary precautions. Frequently it is necessary to educate those of larger experience in certain phases of sanitary work which they have not before encountered. Company officers especially, since they influence the men most directly, should be instructed in the necessity for the measures recommended. Usually both officers and men comply with sanitary regulations promptly as soon as they appreciate their value, and it is the duty of the sanitary adviser to make this manifest. For non-compliance with the published orders recourse must be had to disciplinary measures.

Important as are hygiene and sanitation they sometimes must be ignored. Armies exist in order to win battles and sanitary measures must ever be ancillary to the prime efforts to obtain that end. Military exigencies must dominate before an engagement, during it, and perhaps after it.

History abounds with instances when sickness either caused or aggravated military failures; *e.g.*, the fall of Athens, in the Peloponnesian War and the defeat of the Prussians at Valmy, a conflict which made possible the fruition of the French Revolution. Many other failures of lesser importance may be cited. The steady reduction in the morbidity rates of various armies is due to the advancement of medical science, to the development of sanitary apparatus, and to an appreciation of the value of sanitary measures, but chiefly to an enforcement of compliance with the laws of health by officers of both line and staff.

Though it is impossible to over-emphasize the view that the essential aim of the medical service is maintenance of fighting efficiency of the troops at the front, the great importance of sound sanitation on the lines of communication must be noted. "However satisfactory the civil sanitary organization in the zone of active operations may have been prior to hostilities, it is inevitable that a certain amount of disorganization and inefficiency must result from the increased demands and stress of war. An advancing wave of units, fully officered, equipped and organized, should leave in its wake few insanitary conditions, but the matter is very different when small

detachments subsequently use the line of communication. These detachments lack equipment, trained personnel and organized medical supervision, and consequently the routes tend to become progressively more insanitary. The consequent potential danger becomes an actual menace when the routes still later are traversed by returning infective patients. The ultimate result is that the lines of communication which should serve to maintain the fighting strength by a stream of healthy reinforcements, may prove a source of weakness by passing into the firing line men who have been infected en route to the front, where they become foci of infections which may be spread through the ranks." (Lelean.) It is thus evident that there can be few more important duties for the medical officer in the field than those which deal with the maintenance of sound sanitation upon the lines of communication.

The conditions surrounding the soldier in time of war render him, until he has been hardened, more susceptible than the civilian to certain diseases. The ailments most prevalent in armies in time of peace differ from those in war. During campaigns troops suffer from inclement weather, extremes of temperature, lack of proper shelter, crowding, unsuitable or badly cooked food, overstrain, excitement and anxiety. Sanitary conditions are then often of subsidiary importance and are comparatively neglected with the result that almost invariably disability and death from disease rapidly increase.

The commonest diseases among troops are infections (which as a rule are spread chiefly by contact), digestive disorders, rheumatism, affections of the respiratory and nervous systems and of the heart. In the United States Army the most prevalent infections in time of peace, are venereal diseases, tonsillitis, bronchitis, diarrhea, influenza, pneumonia, rheumatism, measles, mumps, tuberculosis and malaria. The most common causes of death from disease in former wars were cholera and typhus, both of which have invaded armies in Europe during the present conflict. In our war with Mexico the commonest disease was a severe diarrhea, probably an anomalous form of dysentery. In the Civil War the commonest diseases were diarrhea, dysentery, malaria, typhoid fever, rheumatism, respiratory and venereal diseases; in the Spanish-American War and Philippine War, malaria, typhoid fever, dysentery, and

diarrhea. Other diseases which frequently scourged armies are plague and scurvy. In the present war in Europe, the commonest ailments have been nervous disorders, diarrhea, dysentery, frost bite, and (on the eastern front) cholera, typhus and typhoid.

The sick rate is highest for young soldiers under 20 years of age. These men are especially subject to typhoid fever. The disability rate then falls after this age up to the age of 45 when it begins to rise. The death rate is highest in young soldiers 19 years of age and under. It reaches its minimum between 25 and 30 years, rises slightly up to 40 and rapidly thereafter. Rates for both morbidity and mortality are highest during the first year of service; they then gradually diminish, to rise again after 10 years service. The death rate is lowest in the third or fourth year. In the tropics, young soldiers are even more liable to sickness than they are in the United States. The lowest rates of admission, disability, and non-effectiveness in the tropics are among soldiers past 40, though these men furnish the highest death rate.

The healthfulness of an army is not indicated by a comparison of the number of deaths from disease with the number of deaths from wounds. This popular standard of comparison is quite fallacious. The two causes of disability cannot be compared. It would be as reasonable to attempt to determine the salubrity of a community by comparison of the number of deaths from disease to the number of deaths by accident as to determine the healthfulness of an army by similar standards.

CHAPTER II

PERSONAL HYGIENE

Though much can be accomplished by suitable orders concerning hygiene their value can be greatly enhanced by intelligent co-operation on the part of the men. To this end they should receive from the Surgeon certain elementary instructions concerning the care of their persons and their habits.

The importance of an adequate supply of fresh air at night is not fully appreciated by most troops. Men tend to burrow for warmth, and in trench warfare this is unavoidable. If the weather be cold, they close the inlets of fresh air in huts and tents. The resultant re-breathing of contaminated air both lowers resistance to disease and impairs mental and physical energy. The smaller the shelter the better it should be ventilated. Adequate fresh air is especially necessary if there occur an epidemic of any infectious disease of the respiratory organs. The troops in the Punitive Expedition were required in the dead of winter to provide adequate ventilation at night, though they had but scanty bed covers and suffered somewhat from cold. The use of braziers was prohibited as they developed injurious gases. The fact that in but two instances did pneumonia attack two men in the same tent in the El Paso district where fifty thousand men were encamped is attributed largely to the fact that free ventilation of tents was enforced.

In the trenches men warm and dry themselves in dug-outs separated from the main trench by low clay partitions. These are heated by coal braziers. Lack of ventilation is necessitated by military conditions at many points near the front.

Exercise is essential to health. Marching troops are healthy, not only because of occupancy of new camp sites, but because of the exercise they perform. The value of setting up exercises is quickly manifest in recruits. The best form of exercise is that indulged in

as recreation because of the psychological element it introduces. For this reason, athletic sports in which all men participate should be encouraged. Americans as a people prefer to watch games, as did the Romans, rather than to participate in them. Games not only increase the vital functions of organs but their mental effects are stimulating and keep men contented.

Rest is as important as exercise. Men should have eight hours work, eight hours recreation, and eight hours rest. So far as possible, habits of exercise, recreation, and sleep should be regular. It is particularly desirable that men get adequate sleep and that this be as refreshing as possible. Young men require more sleep than older ones. To secure a maximum of benefit men should sleep in loose underwear and have adequate bed covering when in the field. Paper blankets for troops in fixed camps where supplies are limited may be extemporized by sewing a few layers of newspaper between layers of bed ticking, burlap, etc. When these become soiled, they are opened, the paper removed and burned, and the fabric cleansed. Bedding should be aired and bed linen changed weekly.

Bathing promotes the physiological functions of the skin by clearing the openings of the sweat glands which discharge from 1½ to 4 pints of sweat daily and are a most important regulator of body temperature. It also frees the mouths of the sebaceous glands whose secretions oil the skin and prevent it from becoming unduly hardened and rough. Bathing also removes dirt and the germs which may abound on the skin. Forty thousand have been counted on a square centimeter. They may give rise to boils, carbuncles, cellulitis, etc. Also any wound contracted through a skin that is dirty is very liable to become infected. The influence of dirty clothing and dirty skin in causing gas gangrene has been very noticeable in this war. Almost all wounds are infected. The introduction of adequate bathing facilities in our army was followed by a fall in morbidity of about 20 per cent. Many of our most dangerous camp diseases such as typhoid fever, cholera and dysentery are disseminated by dirty hands. Bathing also prevents fouling of the air by emanations from the body due to the accumulations of the excretions and fluid on the skin. Cold baths act as a tonic and have a stimulating effect. Warm baths are sedative. Bathing facilities are discussed in the chapter on camps.

Men should wash the face, head, neck and hands every morning in cold water. The scalp should be washed twice a week. The hands should be washed with soap whenever soiled, before each meal, and after each visit to the latrine. Good soaps for use in hard waters are the Physicians' and Surgeon's, Sayman's, Walke's, "Coal Oil Johnnie" and Palm Olive. Soap is a good disinfectant. The nails should be kept short and cleaned frequently. When cholera is present basins of two per cent. phenol should be provided near the latrines. Nostrils and ears can be kept clean by the insertion of a little vaseline which is then removed by the corner of a towel or handkerchief. Sticks should not be introduced into the auditory canal or nose. It is best that no beard be worn in fixed camp, but if worn it should be trimmed short; daily washed and brushed. In the trenches it is impossible for soldiers to shave themselves daily. Many troops habitually wear beards when on active service in time of war.

Excessive or offensive sweating is treated by painting on the affected area a ten per cent. solution of formalin every other day. Five or six applications may be necessary.

Since cleanliness is even more necessary among men crowded in camps and in cantonments than it is under other circumstances, appliances must be devised and facilities developed whereby it may be obtained. These are considered in the chapter on camps. In the absence of adequate bathing facilities, however, a sponge bath may be used, or the body rubbed with a coarse fabric, *e.g.*, a gunny sack. This expedient gives an unexpected amount of satisfaction.

Men should use their own toilet and smoking articles. By toilet articles especially, a number of infections may be transmitted, *e.g.*, itch, ringworm and other skin diseases, body vermin, gonorrheal infections, syphilis, smallpox, typhoid fever, etc.

Any irritation about the mouth or throat should be treated promptly as it may give rise to ulcerations, abscesses, etc. Especially should attention be given to decayed teeth and to pyorrhea. The importance of this disease is only beginning to be generally appreciated. It is responsible for certain acute and chronic general infections. Many of the latter are usually attributed to "rheumatism." Teeth should be examined at least every six months by a

dentist. They should be cleaned with a soft brush and some tooth powder or ordinary soap twice daily. As the tooth brush is easily infected it should be washed after each using and kept in a container. Indiscriminate spitting should be discouraged strongly as it transmits many infectious diseases.

Proper care of the feet of marching troops is a matter of prime importance. Nails should be cut short and square. Corns should be attended to promptly. After a march especially in hot weather the feet should be sponged, clean socks put on, and those removed, washed and dried. Wet or wrinkled socks especially, should be replaced. Exposed parts should be protected by adhesive plaster or greased with vaseline or tallow. The entire foot and ankle should be anointed if the soldier has to stand in much water, as in the trenches. Tender feet may be hardened by bathing in alum, formalin or alcoholic solutions. Soap or grease applied to the feet or socks before the march will lessen friction. The foot powder issued by the Medical Department prevents abrasions and blisters, and gives excellent results. It consists of 87 parts talcum, 10 parts starch and 3 parts salicylic acid. Soaking the feet does more harm than good as it softens the skin. Blisters that develop on the march are usually treated by pricking them, expressing the water and covering with adhesive plaster. A better method followed by Capt. R. C. Hefflebower, M. C., is the following: The blister and the surrounding skin are painted with tincture of iodine, then a small fold of the raised epidermis is caught between the blades of a pair of scissors and excised leaving a small oval opening about $\frac{1}{16} \times \frac{1}{8}$ inch in diameter. In large blisters additional openings are made. After the fluid has escaped, the area is again iodined, dried and covered with adhesive plaster. The strips of the latter are narrow and overlap so as to conform exactly to the foot surface. Their ends are always brought up over the sides of the foot to prevent rolling and curling. This practice of treating blisters on the feet gives better results than any other yet devised. Woolen socks are best.

Food should be masticated thoroughly and eaten slowly. Large quantities of liquids should not be drunk at meals. Too many articles of poor quality especially fruits and pastry are eaten at the refreshment booths that spring up around camp. The practice of making regular visits to the latrine should be followed. Procrastina-

tion is a common cause of constipation. Natural processes should be promoted by exercise and the use of bulky food.

Alcohol is now rightly regarded as a poison and its use is meeting with increasing opposition. When none is obtainable, the discipline and morale of troops is immeasurably improved. In the Punitive Expedition, many old soldiers who had been frequent sources of trouble rendered impeccable service and the effects of total abstinence were apparent both in guard house and hospital reports.

Smoking if practiced to excess may cause various nervous disorders—headache, giddiness, insomnia, tremor, arrhythmia of the heart, etc., but in moderate quantities, its effect upon those habituated to its use is soothing and its use should not be interfered with. The practice of inhaling, however, is deleterious because of the large amount of nicotine absorbed.

Sexual intercourse is not essential to health. Attempts to exculpate its indulgence by lusty young men, removed from domestic restraint, are far too frequently based on the assumption that the reverse is the case. Emissions are an evidence of vigor and not of its loss. The indiscriminate gratification of sexual desire usually eventuates in contraction of a venereal disease, since most prostitutes are infected. To reduce the prevalence of such diseases among those who are unable to control themselves, the following procedure is practiced in several services. After urination, the penis is washed with soap and water, 10 c.c. of a two per cent. solution of protargol are injected and retained for three minutes. The head, neck and shaft of the penis are rubbed with 33 per cent. calomel ointment in 20 per cent. lanolin and 47 per cent. vaseline. To be effective this prophylactic treatment should be employed not more than an hour after exposure. In order to control venereal disease, troops are inspected twice monthly, once before the 15th and again before the 30th by a medical officer accompanied by an officer from the respective company. Men found diseased are required to take appropriate treatment. Also a record is kept of the prophylactic given, showing the name of the person taking it, date and hour of exposure, date and hour of administration and signature of the Medical Department man administering it. Facilities for the administration of the prophylactic and for keeping this record are provided at the regimental infirmary. Acute cases, other than uncomplicated gonor-

rhea, are transferred to the hospital. Men who fail to take the prophylactic are brought to trial under the provisions of General Orders 17 W. D. 1912, G. O. 31 W. D. 1912, and G. O. 45 W. D. 1914. A record for syphilitic cases is also kept showing the treatment given and progress in each case. It is also necessary to keep a record of the number of venereal cases undergoing treatment in order that any increase in these infections may be detected promptly and controlled.

Prophylactic personal treatment against typhoid and paratyphoid fevers, smallpox and cholera, and personal prophylaxis against malaria, etc., are discussed in the chapter on transmissible diseases.

Clothing should be well fitted, comfortable, with few constrictions, and should not hamper movement, particularly of the chest and abdomen. Shoes should be broad, at least two-thirds inch longer inside, than the foot, as the foot spreads and lengthens on the march. Socks should be well fitting, not too tight, and free from holes. In cold weather in trench warfare, it is especially necessary to have loosely fitting shoes which will accommodate easily two pairs of socks. Shoes should be hob-nailed and made impervious to water by rubbing with neatsfoot oil or castor oil. The best type of foot wear for officers in the field is a high waterproof boot which laces up the front. For the enlisted man the Munson shoe is much more comfortable than the new field marching shoe though not so durable. In the march of the 16th Inf. out of Mexico 12.15 per cent. of the men who used the Munson shoe and 65.13 per cent. of those who wore the marching shoe developed blisters or abrasions (Hefflebower). The best type of foot wear for the soldier is believed to be a loose shoe, on a Munson last with a heavier sole than the latter, hob-nailed, and lightly dressed with neatsfoot oil.

Men require different amounts of clothing and there should be some latitude allowed in the amount of underwear worn. Exposure to heat or cold lowers bodily resistance and should thus be controlled as far as possible. Underwear should be changed if possible weekly in winter or twice weekly in summer and aired nightly in hot weather. Men should not lend their clothing to each other as some of the most dreaded camp diseases may be transmitted in this way. In the absence of adequate warm clothing, comfort may be pro-

moted by a folded newspaper placed underneath the shirt, or a paper or chamois skin vest. Loss of gloves may be prevented by tying these to the end of a cord which passes up the sleeves and across the back.

Laundering presents many difficulties in the field, especially in trench warfare, but its necessity is indicated by the fact that laundry water contains more bacteria than ordinary sewage. The disposal of such water should therefore be practiced with great care and the laundering place for troops on a stream should be that point down stream from which water is obtained,—if possible at a distance from camp. A good plan in semi-permanent camps is for men to boil their clothing in discarded oil cans. If piped water is plentiful and facilities for drainage ample, bath houses may be so constructed as to provide a place where clothes can be washed. Under the usual conditions in camp, however, movable tables or benches should be provided. These should be placed in the rear of each company street, but moved to a new spot every two or three days. Under no circumstances should they be located in shady places. (Lewis and Miller.)

Laundrymen may be employed by the several companies, or other camp followers under adequate supervision may do the laundering by personal agreement with individuals. At Dublan, in Mexico, a laundry employing 120 Chinamen was established by private parties under the supervision of Colonel Glennan, the Division Surgeon, and rendered excellent service at low rates. In fixed camp, company or regimental bath and laundry houses are usually provided. In European services laundries that can handle as high as 5000 pieces a day, are mounted on trains of auto trucks which move to selected points near the firing line. The machinery is actuated from the motors. Bath trains similarly equipped with laundry facilities also operate near the front in the services of the central powers. These organizations are accompanied by a personnel which repairs damaged clothing.

Most men are cleanly and do not harbor vermin. Lice are seldom seen except on recruits or among troops deprived of bathing and laundry facilities, as in time of war. But the men themselves are the main source of infestation by these insects.

Experiments in detail and on a large scale, carried on among

soldiers in billets and trenches, by A. D. Peacock go to prove that the measures suggested below are of great benefit.

1. Whenever possible, and as regularly as possible, the clothing should be thoroughly searched for both lice and the "nits" or eggs. If the removal of the white patch which binds the seams at the fork of the trousers does not interfere with comfort, it is well to remove it. Special care during the searching for the lice and eggs should be paid to this region. Men should be afforded set times for inspecting their clothes. There should be a general inspection by company and medical officers each week.

2. The great source of danger is the presence of eggs on the clothing. These hatch in about a week. It is necessary, therefore, that the trousers should be ironed and brushed at least once a week.

3. Against the lice themselves, whenever necessary, the remedies mentioned below are recommended. Powders, as a rule, should not be used at the fork, but down the shirt and trousers. Care should be taken to see that any powder which falls from the shirt to the fork should be small in amount, as too much is liable to cause smarting. A man in each unit should be responsible for these preparations.

4. Just previous to going to the trenches, the clothing and body should be treated as directed.

5. The preparations should be used about every four days. Experiments in the trenches have shown this to give the best results.

6. Any material, blankets, empty sandbags, etc., which may be present to increase the comfort of the dug-out or billet, should be treated with the powder preparation.

7. Advantage of all the facilities offered at the bath should be taken.

8. Old clothing should be removed.

"N. C. I." (much used in the British service) consists of naphthalene 96 per cent., creosote 2 per cent., iodoform 2 per cent. This preparation is a speedy killing agent and is the best all-around vermicide tested. One ounce per man per week should be dusted on the body or between the layers of clothing.

For practical purposes Peacock found that destruction of lice and their eggs is best secured by immersion of verminous garments and bedclothes in a gasoline or benzine bath. Danger from fire and

waste are avoided by using such a bath and extractor as are employed in a dry cleaning apparatus. In such an apparatus 90 per cent. of the gasoline or benzine is recovered for future use. A gasoline or benzine bath is effective, especially for uniforms and woolen garments generally. When this can not be effected "Vermijelli" may be employed. This consists of soft soap 5 parts, mineral oil 9 parts, water 1 part. One ounce is applied weekly to the seams of the clothing The object is to destroy the young as they hatch.

In Pershing's expedition into Mexico 3 gallons of gasoline per man were necessary for "delousing" purposes. Maj. C. D. Buck, M. C., found that the same result was obtained by placing a layer of clothes on a sheet of canvas, sprinkling with gasoline, adding another layer, again sprinkling, etc. The canvas was closed, tied tightly and left for 3 hours. Where the clothing is such that it is not injured by immersion in water, steeping the garments for half an hour at 12°C. (54°F.) in a soap solution containing 2 per cent. of trichlorethylene or 10 per cent. of tetrachlorethane is effective. Or they may be steeped for one hour in a solution of 1 pint of cresol to eight gallons of water, disinfected by steam, or merely boiled in soapy water for 5 minutes. Steeping for half an hour in a 5 per cent. solution of cyllin in water maintained at 65°C. (149°F.) is effective on woolen articles. Frequently these are treated by ironing, when wet, especially along the seams, and vigorous brushing with a stiff brush. For reasons of economy the chlorine derivative of ethane and ethylene can not be used at present in a dry cleaning process, but their soap preparations are of value.

For cleansing the body itself, bathing or sponging with soap solutions containing 2 per cent. of trichlorethylene or 10 per cent. tetrachlorethane gives the best results. In view of the known insecticidal action of these chlorine derivatives of ethylene and ethane, it is probable that good results would be obtained by shampooing verminous heads with their soap preparations, and it is also probable that a 25 per cent. solution of trichlorethylene in vaseline would form an efficient insecticidal ointment.

It is almost certain that lice would not continue to live on the human body if anointed daily with a 25 per cent. solution of trichlorethylene in vaseline or on the body anointed twice daily with a solution of gasoline in vaseline, of similar strength. The odor of

such ointments is not pleasant, but when living under verminous conditions, constant precautions have to be taken and every method of destroying vermin should be employed. Any attempt to render an army free from vermin in war time would require that all men occupying the same quarters at the same time, or for alternating short periods of time, should be regarded as a single unit for which a receiving station with cleansing apparatus should be provided. Such an attempt would also require that the movements of the men off duty be controlled. This would be limited by military necessities.

After examining a number of known remedies, which were all reprepared and tested, Soulima and Elbert considered the following agents to be the most efficient and the best adapted to the circumstances of armies in the field: (*a*) 35 per cent. cresol and 65 per cent. naphtha soap; (*b*) 35 per cent. xylol and 65 per cent. naphtha soap; (*c*) 5 per cent. turpentine, 5 per cent. gasoline, 2 per cent. oil of cinnamon and 88 per cent. talc. The first named is specially useful, as it not only kills the lice and their eggs rapidly, but the odor, which is retained for a long time by the clothing, will keep the lice away for several weeks. A 10 per cent. solution in water is recommended, body linen to be soaked in it, all outer clothing well wetted, and the mixture rubbed in with a brush.

The mixture which was most satisfactory in Legroux' experience consisted of oils of lemon grass, pennyroyal and eucalyptus, 300 c.c. of each, and powdered naphthalene, 100 grams. The oils evaporate in the order given. Pieces of cloth or felt carrying from 6 to 8 drops of this mixture and fastened to the underclothing at those spots where lice generally congregate will prevent breeding. To cleanse the clothing, ironing the seams and doubled or lined parts with a very hot iron is effective. Linings should be wetted with 5 parts of the mixture in 100 parts of alcohol and ironed at once. Military accoutrements should be put into a barrel or other container which can be closed almost hermetically and exposed to the vapor of the mixture at a temperature of from 105° to 112°F. Five c.c. per cubic meter are sufficient and the exposure should be for 20 minutes per cubic meter. Eggs on the hair may be destroyed by an ointment made from 2 c.c. of the mixture and 8 grams of vaseline well blended.

Perhaps the best method of destroying both lice and their eggs

in clothing is to subject the clothing for 20 minutes to the action of steam under pressure. The whole of the clothing must be treated at the same time, and, as complete change is not possible in the field, the process fails in practice even when the somewhat cumbrous

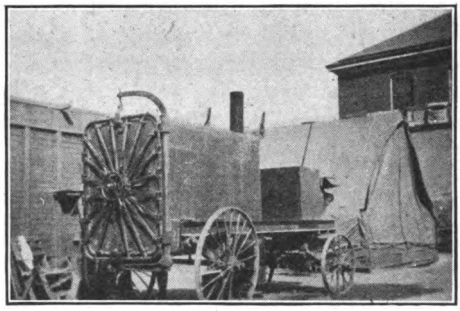

FIG. 1.—Rolling steam or formalin disinfector, closed.

apparatus can be set up. This difficulty is overcome in the Austrian service which provides bath trains where 3000 men a day can be bathed and their clothing disinfected. Reserve clothing for these men to use in the meantime is carried on the train.

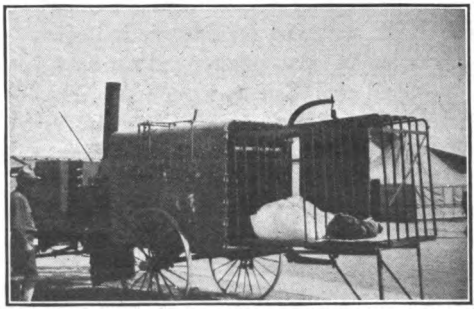

FIG. 2.—Rolling steam or formalin disinfector, open.

A 2 per cent. solution of cresyl, freshly prepared, is quite sufficient to kill all lice with which it comes into contact for 10 minutes. A quart of cresyl in 12½ gallons of water is enough to kill the lice in the body linen of 62 men, each garment being wrung out to recover the

liquor as far as possible. Careful and vigorous brushing of uniforms with a hand brush in the open will rid them of both lice and eggs, which fall on the soil and die.

H. C. Hall, 1st Lieut. M. R. C., recommends the following method of destroying lice and their ova. When nits are found, even though the louse is not discernible, it should be considered that the vermin are present and the following procedure instituted. Clothing other than woolens and leather articles should be placed in boiling water ten minutes, or clothes including woolens should be soaked in a

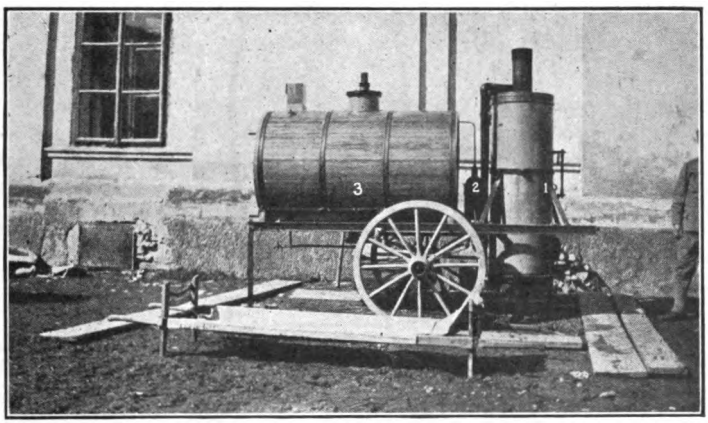

FIG. 3.—Field clothing disinfector. 1, Boiler; 2, formaldehyde generator; 3, disinfecting chamber. (*Austrian Service.*)

mixture of equal parts of hot vinegar and kerosene. This mixture kills both vermin and ova, the former ingredient destroying the louse, the latter its eggs. After soaking, the garments are passed through a clothes wringer to remove as much of the solution as possible. Gasoline he states will loosen the nit from the hair but does not destroy it. For head lice, clip the hair, apply the above mixture, and wash with soap and water. The axillæ and pubes should be inspected for head, body, and crab lice.

To properly apply fumigation every door, window, and crack should be sealed and objects in the apartment well spread out.

Instead of one large deposit of fumigant, several smaller ones in various parts of the quarters should be employed. Sulphur fumigation is very reliable for rats, bedbugs, lice, and fleas. There should be an admixture of at least 10 per cent. of sulphur dioxide with moist atmospheric air, *i.e.*, 5 lbs. of sulphur should be burned for each 1000 cubic feet of space. Disinfection is not completed within less than 12 hours. The following method is the safest and cheapest means of using sulphur. Six inches of wet—not moistened—sand are placed in a 5-gallon gasoline can. The sulphur is placed

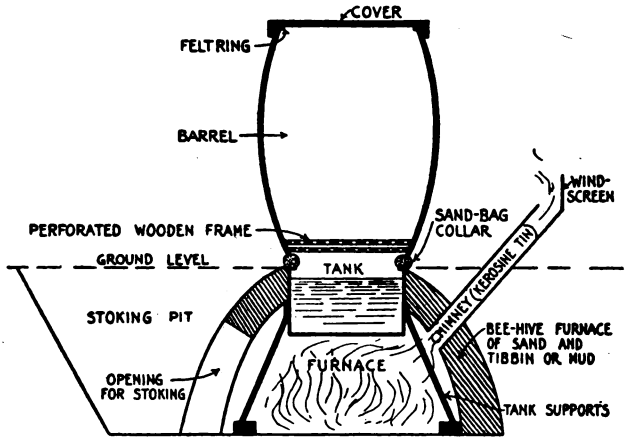

FIG. 4.—Serbian barrel. The underground furnace economizes heat and brings the top of the barrel to a convenient level. A series of barrels may be arranged over a trench and embedded in mud. The depth of the water tank should be comparatively small in proportion to its area. Clothing to be disinfected is placed in this barrel. (*After Lelean.*)

in an earthen pot and lowered into the sand. Holes are punched in the sides of the can two inches and more above the top of the pot to allow a ventilating draft of air. Alcohol is poured on the sulphur and lighted; the top of the can is now closed and a pot of water placed on it. The heat from the burning sulphur will boil the water in this pot and develops the moisture needed to make sulphur fumigation efficient. Where time is an important element, sulphur is too slow and uncertain.

For practical purposes formalin fumigation will not destroy insect vermin satisfactorily. Hydrocyanic gas is quick in action, an hour's exposure sufficing. It does not destroy fabrics, is very penetrating, and destroys most of the eggs of vermin when brought into direct contact with them. Its great drawback is its danger to human life. It may be generated as follows. Potassium cyanide and commercial sulphuric acid of each an ounce to 2½ ounces of water are employed for each hundred cubic feet of space. The potassium cyanide is placed in a piece of cheese-cloth (or better in a large castor oil gelatine capsule) and dropped into the mixture of sulphuric acid. An old box car, all openings being sealed, makes a convenient disinfecting chamber for the service of contiguous camps on the railway line.

To prevent the spread of lice in Germany every soldier is "de-loused" before he is allowed to leave the front and in every railroad station a soldier is posted who demands of every military person who comes from the front his card certifying that he has been thus treated. In the prisoners camps, "de-lousing" is done with very simple means. The lice are killed with steam and dry heat, applied in a wooden building lined throughout with roofing pasteboard. The steam is developed in a locomotive which is run close to the barracks. The men enter a room and deposit their watches and other valuables in a locker opening also into the outer wall. The clothing is marked with a number, hung upon a hook, and carried into the sterilizing room where it hangs in rows as in a wardrobe. A tube brings the steam from the locomotive. It enters with a force of twelve atmospheres. A wooden screen prevents the steam from blowing the clothing off the hooks. Maximal thermometers are suspended among the clothes and a thermometer and manometer are arranged so they can be read from outside. In the course of half an hour the temperature in the room is brought to 110°C., which is more than enough to kill lice. Leather goods are sterilized with dry heat in another room heated by the steam as it goes through the pipes. In the meanwhile the men have passed into a room where the hair and beard are cut, the hair on the bodies being shaved. They pass then into a room where there are large tubs and douches. Here the men are soaped and scrubbed. They then pass into another room located on the other side of the

sterilizing room and their clothing is handed to them, well dried. After the sterilization they then leave the establishment, getting their valuables by unlocking the lockers from outside the building. A thousand men can thus be de-loused and cleansed in an hour's time. The barracks themselves can be disinfected as required, by steam from the locomotive.

In order to control the presence of vermin among camp followers in the Punitive Expedition these persons were brought to the office of the Camp Surgeon by the guard when they sought to come in past the outposts. Their persons and their clothing were examined for vermin. If any were found, clothing was immersed in gasoline and a gasoline sponge bath given, followed by soap and water. The camp follower was then given a pass good for ten days, at the end of which time he was required to return for re-examination. At this time also he was given the first dose of typhoid prophylactic and was vaccinated. A record was kept showing the name of each person thus treated, dates of typhoid prophylaxis, vaccination and last examination. Sentries were instructed to examine the passes of civilians in camp, and, if these were obsolete to deport bearers beyond the outposts. At Columbus, N. M., a "de-lousing" plant was erected, consisting of a sheet iron box 20 feet square divided into four rooms. In these successively, persons undressed, took their gasoline bath, a bath of soap and water, and re-dressed in clothing which had meanwhile been soaked in gasoline and dried. In this arid and sunny climate garments dried quickly.

The following thirty admonitions pertaining to personal hygiene were published to the Eleventh Division, El Paso, Texas, upon the recommendation of Maj. H. L. Gilchrist, M. C., U. S. Army, Division Surgeon.

Don't disobey the laws of common sense; fail to realize that you, personally, are responsible for the condition of your health, and if you take the same care of yourself in camp as when at home, there is no reason why your health should not be equally as good if not better; fail to keep your person clean at all times; fail to take a bath at least once each week and put on a clean change of underclothing; fail to wash your hands and face before eating; fail to wash your hands after visiting the latrine; fail to have a good toothbrush and use it once daily at least; fail to change your socks fre-

quently; fail to keep your finger nails clean at all times; fail to have your bowels move at least once each day; keep your tent too hot; think cold pure air is detrimental to good health; think hot impure air is conducive to good health; sit around a hot fire in a closed tent on a bright sunny day; fail to keep your tent properly ventilated at all times; fail to air your bedding daily; fail to extinguish the fire in your tent before retiring, remembering that it burns up the oxygen or air intended for you; enter a heated tent and fail to remove your overcoat or sweater, immediately upon entering; leave a heated tent and go out into the cold, bare-headed and without proper clothing to protect the body; fail to realize that colds are contagious, and avoid the breath of one suffering from such condition; fail to devote several minutes daily to taking lung exercises; fail to seek the advice of your surgeon when feeling ill and fail to follow his advice when given; eat too rapidly; take active exercise either before or after a hearty meal; over indulge in alcoholic liquors; forget that the large majority of prostitutes are diseased; fail to use a prophylactic immediately after having intercourse with a prostitute; censure your commanding officer or the Government for the condition of your health if you disobey these rules.

To these, for troops in the trenches may be added. Don't fail to examine clothing and person, on every opportunity, to rid them of lice. Don't fail to brush or shake clothing frequently. Don't wear tight shoes, or other clothing. Don't forget to oil your feet before going into wet trenches. Don't fail to dry wet shoes and socks when opportunity permits. Don't fail to exercise hands and feet when these are cold.

CHAPTER III

THE MARCH

Marching is the simplest, most important and most exhausting form of military exercise. Its importance in the present war has not been as apparent as in others for the troops occupy what are in effect elongated fortresses and when they must be moved quickly from one part of the line to another they are carried often in motor trucks. Nevertheless, numerous occasions yet arise when speedy movements by marching are essential. Consequently the aphorism attributed to Napoleon that more battles are won by legs than arms is not yet entirely obsolete. All branches of the service, but especially the Infantry, should be trained in marching. The latter should be able to cover from 15 to 20 miles a day without much fatigue.

When practicable marches begin in the early morning after ample time has been allowed for men to breakfast, for animals to feed and water, and for wagons and animals to be packed. Breakfast should be very digestible, otherwise it will not be assimilated and will be a source of weakness instead of strength. Meat extracts such as beef tea and soups favor assimilation. If the march is to be a long one the men should carry luncheons, unless rolling kitchens or fireless cookers accompany them. Canteens are filled, also water carts, if these are used. If water require purification this should have been done the preceding evening. Fires should be extinguished, kitchen and latrine pits filled and camp thoroughly policed immediately before departure.

The march should begin and end slowly. A full meal should not be served until half an hour after arrival in the next camp.

A successful march places the troops at their destination in the best possible condition. This event is secured by careful preparation, strict discipline and due observance of sanitary precautions. Ample notice should be given so that preparations should be made

without haste. Hardship should be reduced to a minimum. Marching troops are usually healthy. During Sherman's march to the sea which lasted six months, the sick in the Georgia column were less than two per cent. and in the Carolina column 3.4 per cent. though this was operating in swampy country and much harassed by the enemy.

Foot troops do not start as a rule before broad daylight and mounted troops an hour later. Men and animals get their best sleep in the early morning. Animals will not water as a rule before daylight. In hot weather the start is made as early as possible subject to the above limitations. During the heat of the day, especially in the tropics, the troops may halt from 11 to 4 when the march is resumed, but as a general rule troops prefer to finish the march as soon as possible after it is begun. Also arrival at a strange place after nightfall occasions difficulties otherwise avoidable. Night marching is to be avoided as it has a most injurious effect on both men and animals. Its deleterious results were manifested by French's division in South Africa.

The march is usually at route order. In this the men are not required to preserve silence nor keep step but the ranks must cover and preserve distance. The military step is more fatiguing than that of ordinary walking for its movements are constrained and there is much loss of energy in the vertical oscillation of the body. The attitude assumed in marching should approximate that of a person about to ascend a flight of steps. Body and head are inclined forward and the chest is thrown out to favor breathing. The feet should be raised just enough to clear obstacles and the muscles of the front of the leg relaxed when the foot strikes the ground. If heel and toes strike almost simultaneously shock is reduced. The foot should be slightly everted but not more than 10 or 12 degrees.

Infantry usually marches in column of squads, column of twos being formed only when the road is narrow or the weather hot. Cavalry marches in column of fours on good roads or when compact formation is necessary, otherwise in column of twos. Artillery marches in single column of carriages or very rarely in double column if breadth of road permits. When Infantry are in column of four, Cavalry in column of two and Artillery in single column, the following road spaces may be assumed, viz., two men for each

yard of Infantry, one man per yard for each mounted man, 20 yards for each gun, caisson or wagon and 12 yards for each auto truck.

The rate of march for mixed commands is regulated by that of the foot troops but is modified by a number of circumstances. It varies with the length of the march, condition of the troops and the size of the command. The longer the column, the slower its rate. Sandy, rough, muddy or slippery roads, broken country, narrow defiles or bridges, dust, great heat, strong head winds, storms, ice, and snow, all reduce the rate of speed. The rate prescribed for Infantry is 100 yards per minute or 3¾ miles per hour. On the road the maximum expected is 3 miles an hour, or, including halts 2½ to 3 miles an hour. Under average conditions the rate of an Infantry column is from 2¼ to 2½ miles per hour. The average march of Infantry is about 15 miles a day but for large bodies, it is about 12 miles. Small commands of seasoned troops marching on good roads in good weather can average 20 miles a day. The maximum for one day's march for seasoned Infantry may be assumed to be from 28 to 30 miles but a march of this character cannot be prolonged as a rule more than 36 hours. History presents many exceptions however to this general statement as the march of Friant's Division to Austerlitz (78 miles in 46 hours). Forced marches impair the efficiency of troops and their fighting abilities. Foot troops make them by increasing the number of marching hours and arranging accordingly the periods for halts, sleep and cooking. As far as possible they follow the rules for the average march. In forced marches of mixed commands, foot troops are favored as much as possible. They are not intermingled with other troops, they are assigned the best roads, their packs are lightened or carried on wagons if possible.

The average rate for Cavalry in the field is 3¾ miles an hour or including halts 3¼ to 3½ miles. The usual gait is the walk. The average march after men and animals are hardened is 25 miles a day.

Under favorable conditions of road and weather a rate of 50 miles in 24 hours can be maintained for three or four days. On such marches the usual hourly halts are made. In addition, a halt of two hours is made at the end of the first half of each day's march, during which the horses are unsaddled and permitted to roll, feed and lie down. The rate is about 5 miles an hour, excluding halts.

Under very favorable conditions a single march of 100 miles can be made in from 24 to 30 hours. On such a march the usual hourly halts are made; in addition halts of 2 hours are made at the end of the first and second thirds of the march, during which the horses are unsaddled and permitted to roll, feed and lie down. The rate is about 5½ miles an hour, excluding halts.

For distances from 30 to 40 miles a rate of six miles an hour, excluding halts, can be maintained under favorable conditions of road and weather. If the command be small, well seasoned and lightly equipped, the rate may be even greater. The usual halts are made.

If the distance to be covered by forced marches is about 150 miles, the march begins at the rate of not more than 50 miles a day. For distances greater than 200 miles the daily march is from 30 to 40 miles.

On forced marches where the road is level or nearly so and the footing good the men are occasionally required to dismount and march for short distances at a fast-walk or slow double time, leading their horses. They are also permitted to loosen or remove their sweaters or overcoats, if their comfort will be materially increased thereby.

Field Artillery, if alone, covers 15 to 20 miles a day. Otherwise its rate is that of the command of which it forms a part. Horse Artillery has the rate of the Cavalry it accompanies.

Trains drawn by animals make from 2 to 4 miles an hour according to the condition of animals and roads, size of loads and length of column. The length of the daily march is about the same as that of Infantry.

Troops should be informed of the length of halts and should not be kept under arms longer than is necessary. The first halt is made after marching three quarters of an hour and is of about fifteen minutes' duration so that men may attend to the calls of nature. For this reason, it should not be made near habitations. Thereafter troops in the American service usually halt ten minutes in every hour. In hot weather, in difficult country, or for unseasoned troops, halts may be made at more frequent intervals and for longer periods. The men fall out and remove equipments, but remain near their places in the column. Intervals of marching may be modified slightly to take advantage of good halting places such as those

with clean dry sites affording shade in summer or protection from wind in winter. Men should not sit or lie on wet ground. In certain services, if the ground is wet, a few men form a circle and sit on one another's knees.

For Cavalry after the initial fifteen minute halt five minute halts are allowed during which the men examine the animals feet, adjust saddles, etc.

Artillery halts for five to ten minutes, adjusts harness, etc.

Special attention should be given on the march to the backs of animals. The pack or saddle blankets should be smooth. If bunches form, a sack wet with cold water should be kept tightly cinched over them during long halts and at the end of the march and they should be rubbed by hand at frequent intervals.

Long halts in good weather are not desirable unless the march be more than 15 miles for Infantry or 25 miles for Cavalry. In such cases, a halt of an hour may be made at meal time on a favorable site. The men stack arms and remove equipments. Mounted men re-adjust saddles and loosen cinches.

Halts are not made in towns or villages except to procure water or supplies. In continental armies mounted men or cyclists are sent ahead to instruct citizens to put out tubs and buckets. The men remain in column and details are sent for whatever is necessary. Commands the size of a regiment usually halt simultaneously at the word of command; in longer columns a simultaneous halt may be made by synchronizing watches before the march begins and by determining upon the designated moment for the halt.

The chief difficulty on the march especially in hot weather is controlling thirst. Many troops have the water habit and will empty their canteens at the first halt. The difference between habit thirst and necessity thirst should be recognized clearly. Unnecessary water drinking causes profuse perspiration and gastric disturbance, and is distinctly weakening.

The body temperature on the march rises to from 100.4° to 101.4°. This is physiological and is necessary for the efficient performance of work. It may go up to 102° without ill effects. The optimum temperature is about 100.5°. It is kept from rising too far chiefly by evaporation which is favored by suitable clothing and the proper amount of water. On a march of 15 miles, 1300 calories must be

dissipated by evaporation, unless the weather be cold. The evaporation of one quart of water will remove 600 calories, so that on a march of this length and at its end, a little more than two quarts are necessary to replenish the amount of fluid lost. At the end of 7½ miles the soldier will have evaporated one quart of water. For seasoned troops this should cause no inconvenience but the loss of two quarts is followed by slight discomfort. The loss of one gallon is dangerous.

Water should be drunk only at halts and at the word of command. Each man should drink one pint of water after marching 7½ miles and thereafter one-third of a pint hourly. By this means a steady supply fully adequate to meet requirements is afforded and the amount of body fluids kept well within normal limits.

This procedure based on evaporation statistics, etc., is applicable in such climates as those of middle and western Europe. In hotter and drier climates a larger amount of water is necessary.

There is no other element of the march except the care of the feet which has so direct an influence upon the welfare of the troops as has the proper use of drinking water.

Canteens should be filled by order and not by straggling. Uncertainty concerning the quality and quantity of the water next available after canteens are emptied is also a reason for causing preservation of the supply on hand. If practicable, sources of water should be examined by field laboratories and marked good or bad.

Weak tea or coffee slake thirst better than water. Also they are sterilized. Sugar is a tonic and a muscular restorative which is immediately assimilated.. It may be used to advantage in tea or coffee or in the form of chocolate.

Thirst may be alleviated by carrying in the mouth a bullet, pebble or twig. On long marches when the local water supply is inadequate or for the service of troops in the trenches, a supply should be provided carried on vehicles or pack animals. (See chapter on Water.) The effects of exposure to direct rays of the sun are alleviated by the wearing of leaves or a moist handkerchief in the hat and the use of smoked glasses.

If the temperature is high and the atmosphere humid, in order to prevent heat exhaustion, the men should march in files on each side

of the road, leaving the middle open. Shirts and collars should be opened, sleeves rolled up, and loads lightened by means of one wagon for each battalion.

If a number of men are overcome by heat in a short time, an aid post should be established in a shady place and the incapacitated left in charge of a subaltern if the regiment is obliged to continue its march. This situation very rarely occurs in well-seasoned troops.

In cold weather especially if attended with wind, rain or snow, the men should march in column of fours. At every quarter hour the exterior files should be replaced by the interior ones.

Our regulations require that men falling out on the march present a pass signed by the company commander when they seek assistance from the surgeon. The object of this order is to prevent straggling. In the French service, passes of two colors are given. One indicates that the man should be relieved of his equipment, the other that he should be admitted to the ambulance. The object of this is to facilitate prompt action on the part of the surgeon, thus avoiding delay to any organization in the rear. If the pass indicates that admission to the ambulance is believed advisable the surgeon enters the ambulance and there makes an examination while the vehicle continues its march. Men who have been admitted to the ambulance may be discharged after resting several hours to be replaced by others.

In hot weather or where the supply of water is doubtful, animals should be watered before leaving camp, but frequently they will not drink before sunrise or until about ten o'clock in the forenoon. Use should be made of opportunities to water on the march. Artillery and train animals are either watered in camp or during long halts on the march.

Straggling is to be prevented vigorously. It has a demoralizing effect both on the individual and on the command.

Care of the feet is discussed in the chapter on Personal Hygiene. Injuries to the feet are prevented chiefly by well fitting shoes, well fitting socks and cleanliness. Injuries received on the march which require medical attention are teno-synovitis and tarsalgia (which often complicate flat feet), and fractures of a meta-tarsal bone (usually the second). Such fractures are the result, as a rule, of marching over rough ground, in worn shoes. The surgeon should

examine the men's feet daily and treat minor injuries until the men have learned to care for these themselves.

An irritable condition of the heart not infrequently follows severe marching, especially in hot weather. It is manifested by shortness of breath, a degree of exhaustion, and an irregular and intermittent pulse which is increased in frequency upon very slight exertion. The patient may ultimately recover under a complete rest treatment which is usually protracted.

This condition should not be confused with the normal increase of the heart beats which follows ordinary marching. The pulse may reach 140 without manifesting a morbid condition.

CHAPTER IV

CAMPS

The selection of a camp site, as stated by Lord Wolsey, should be determined by sanitary conditions if contact with the enemy is not expected within 48 hours. In the presence of the enemy or before or after a battle, or while marching or maneuvering for position, sanitary considerations must be utterly subordinated. Troops may have to camp many nights on objectionable sites. "Nevertheless sanitary considerations are given all weight possible, consistent with tactical requirements." (Field Service Regulations, U. S. A.)

When no tactical requirments need be considered and the camp is to be occupied several days or weeks, great care should be exercised in selecting its site. Occupancy of an insalubrious location may cause greater losses than the battles of the campaign. An experienced medical officer should assist in the location of a camp. In this matter, his responsibility is very grave.

The camp should be located on ground high enough to secure a dry soil and good drainage, but this should not pollute the grounds of a camp which might be established below it. A large ditch below the camp may overcome this difficulty.

Favorable sites are low ridges with gentle slopes, a gently sloping plateau, or the high bank of a river. In cold weather a slope to the south with woods or hills to the north to break the force of winds is advantageous. In hot weather the camp should be on high ground free from underbrush but shaded with trees. Trees and shrubs protect from the sun and modify extremes of temperature.

The soil should be dry, porous, and drain easily. Healthy camp grounds are gravel, sand, loam and volcanic rocks such as granite, trap and gneiss, except when fissured or too level to afford good drainage. A rocky soil, however, often presents difficulties in driving tent pegs.

Undesirable sites are the following: (1) Vicinity of marshes, or stagnant pools for they render the soil damp, exhale noxious gases, and breed annoying insects. (2) Old camp grounds, which have not been disinfected by sun, wind and rain. The time for this varies widely but as a rule in dry weather, two or three months will remove danger of soil infection. (3) The vicinity of cemeteries is liable to be polluted by the action of earth worms in bringing disease causing germs to the surface. (4) Thick forests, the base of hills, dense vegetation, made grounds, clay or alluvial soil, punch bowl depressions, enclosed ravines. In all of these the soil is damp, or in the three last mentioned sites becomes so after scant rainfall. Moisture in the soil renders it cold and predisposes to neuralgia, diarrhea, rheumatism, etc.

The ground water as a rule should be at least 10 or 12 feet from the surface but in porous soils 6 or 8 feet may be sufficient. Clay and marl sites are especially undesirable. White sand does not absorb much heat during the day, loses little at night, and usually contains but little organic matter. If nearly pure, however, it is soft to the foot and its glare is troublesome unless colored glasses are worn.

The water supply should be adequate, accessible and suitable for drinking purposes without purification. All proper economy in the use of water should be exercised, especially in bath houses, in order to prevent waste and to avoid insanitary puddles. Drainage ditches should be dug when necessary. Except in very dry climates or over porous soils the disposal of waste water is the most difficult problem in camp sanitation.

Wood, grass, forage and supplies should be at hand or readily obtainable. Grass should be preserved and protected as it mitigates the heating of the soil by day and its chilling by night, prevents mud and dust, and does not reflect light and heat. Since vegetation affords insects shelter in their flight, camps in malarial countries especially should be cleared of underbrush. In this circumstance high grass and other vegetations should be cut. A screen of trees between mosquito breeding waters and a camp will prevent many of these insects reaching it, but a line of trees, high grass or bushes, extending between the two will facilitate their travel and should be destroyed.

In enemy territory information should be obtained from the inhabitants concerning any prevalent disease of man or animals in the proximity of the camp grounds.

The site should accommodate the command with as little crowding as possible. The concentration of large numbers of men under primitive hygenic conditions favors the spread among them of infectious diseases. This is limited by giving each man as much space as possible. Not more than 5000 men should be placed in one camp if avoidable and its organizations should be scattered as far as tactical considerations, topographical conditions and facilities for internal administration permit. There should be good roads to the camp and good interior communications. Mounted men should keep to the roads.

The form of the camp should be such as to facilitate the prompt location of troops after a march and their prompt departure when camp is broken. The form assumed in any given instance will depend upon tactical conditions and the area and configuration of the site. In the presence of the enemy camp sites are contracted but when tactical considerations need not be considered expanded areas are utilized. Forms and dimensions of camps are given in the appended data from the Field Service Regulations.

When camp is to be established the point where each organization is to locate is designated. Places where water is to be obtained for drinking and cooking purposes, where animals are to be watered, and where clothing may be washed, are defined. Such places are located in the order mentioned from upstream down. Guards should be posted at once to insure proper use of the water supply. When several commands are encamped along the same stream, the senior officer present exercises control in designating sites where water is obtained for the purposes mentioned. If the water supply is of doubtful purity, it is treated in the manner indicated in the chapter on water.

Men should not lie on the damp ground. In temporary camps they should make beds of grass, leaves or boughs, or use ponchos or slickers. In cold weather, if fuel be plentiful the ground may be warmed by fire and beds made after ashes are raked away.

SHELTER

In camp troops are usually under canvas. It gives shelter against sun and rain, to some extent against cold and wind, but chills or heats up rapidly and does not afford protection such as that given by even the most primitive buildings. In the United States at least, tentage is more expensive than structures built of lumber if occupancy lasts more than six months. Comfort in tents is promoted by flys which should fit more closely in winter than in summer. In sunlight the temperature is higher in a tent than in the shady open

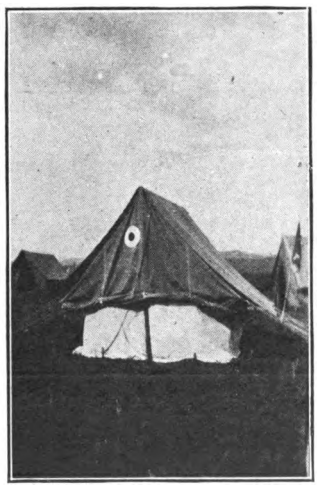

FIG. 5.—Screened tent.

air. In countries where insects abound tents may be screened. In cold weather tents are made more comfortable by lining the wall with flannel or paper. Comfort is promoted in protracted camps by erecting tents on walls 2 to 6 feet high made of wood or of adobe bricks. These walls conform to the dimensions of the tents. In sandy soil where tent pegs will not hold these may be replaced by bundles of brush which are tied to the tent ropes and buried in the sand. In fixed camps, tents or roofs are sometimes erected over excavations to promote warmth but this advantage is offset by

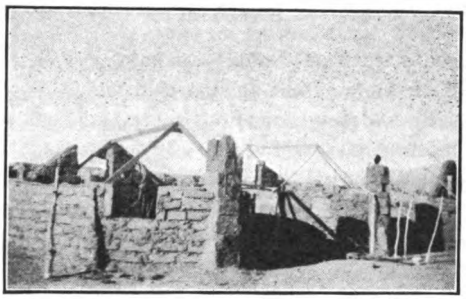

FIG. 6.—Frames for tents on adobe walls.

FIG. 7.—Shelter tents on walls.

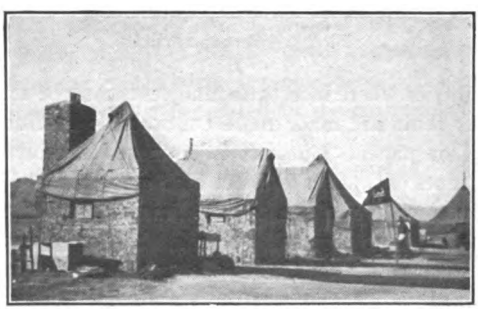

FIG. 8.—Pyramidal and hospital tents erected on adobe walls.

dampness and the practice should be discouraged. Tents may be heated by Sibley stoves, by adobe brick fireplaces with chimneys made of mud or tin, or by galvanized iron cans or tins closed at the top except where the stovepipe emerges. Spark arrestors should be provided, preferably at the top of the chimney where their condition is readily noted. They soon clog in this situation but if inserted in the stove pipe where it leaves the stove they burn out quickly and their condition is not so easily determined. Tents may be heated also by grouping four tents around a central fireplace; by a crescent shaped wall against which an open fire is built in front of a tent and which reflects the heat into it; by making a fire pit in

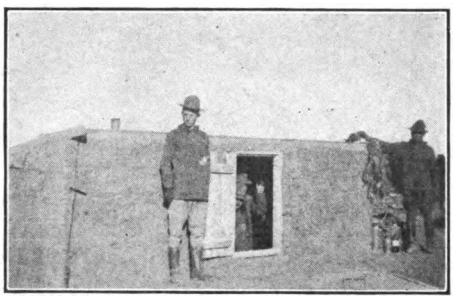

FIG. 9.—Semi subterranean quarters.

front of the tent and leading the heat and smoke in a zigzag course across the tent floor to an outside chimney; or by erecting three tents against three sides of a hut which is heated by a stove and which communicates with the tents by doorways. Board flooring increases comfort and available space. If this is not obtainable, the floor may be made of three inches of fine gravel or of a layer of stone of the same depth filled in and covered with well tamped earth. Tents should be ditched in permanent camps or if the weather is unsettled. In summer, tent walls should be raised or tents furled daily, weather permitting, in order to air bedding and clothing. In cold weather, ventilation should be insisted upon. Lewis and Miller secured this in the pyramidal tent by replacing the hood with a metal cap which had a hole to accommodate the stovepipe. The cap was supported at a height of four inches above the canvas by two small pieces of

timber. This device promoted ventilation and protected the tent from rain, but to secure adequate results, it was supplemented by leaving tent doors partly open.

Where timber is obtainable and the camp is of some duration, log huts with well plastered joints, canvas roof and fly, afford excellent protection and are preferable to tents. Smart's hut, built of log walls with a canvas roof, measures 13 × 7 feet and is 6 feet to the eaves. It can accommodate 4 men on two double bunks, one

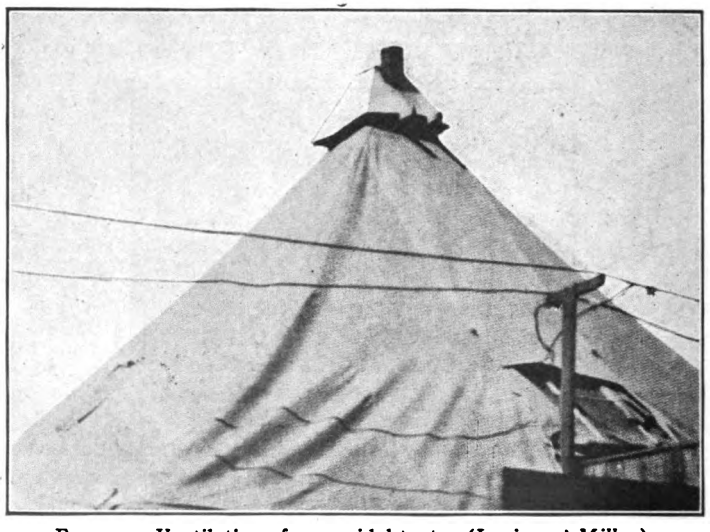

FIG. 10.—Ventilation of pyramidal tent. (*Lewis and Miller.*)

on each side of the doorway. Light and ventilation are provided by roof, door and chimney. Woodhull recommends two huts, 8 feet by 11 standing end to end 6 feet apart, with doors opening upon a connecting porch. Each hut accommodates four men. In a cold climate one fireplace and chimney between the huts is sufficient.

Cantonments.—When lumber is available cantonments may be erected. Huts may be made to accommodate from 100 to 150 men. They should be built of shiplap and in cold climates should be cased inside by boards nailed to the scantling uprights. In warm climates

this inner boarding may be replaced by heavy paper or dispensed with. At Fort McPherson, Ga., barracks were erected in 1898 with tar paper exteriors and heavy paper lining the scantlings. Similar

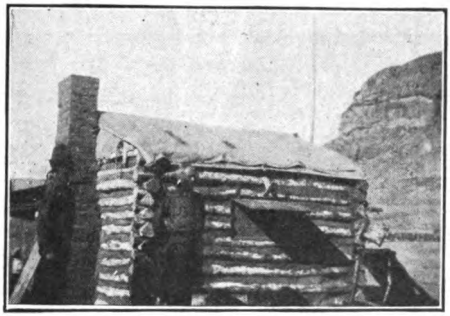

FIG. 11.—Log hut.

construction of hospital buildings on the line of communication has been employed by Austria during the present war. Warmth is due to the air blanket created more than to the materials employed.

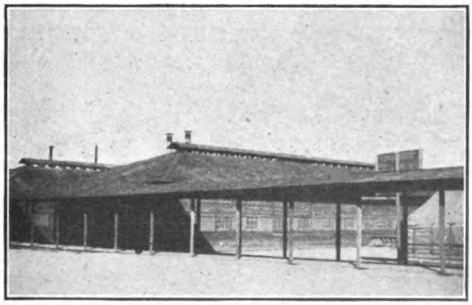

FIG. 12.—Hospital wards, Base Hospital No. 2, Fort Bliss, showing monitors along ridge and panels in wall.

Buildings in cantonments, in warm climates especially, should be ventilated by monitors extending the entire length of the building. These are screened with mosquito netting. Panels are provided in the ceiling whereby in cold weather ventilators may be closed in part, and heat retained. Panels are also provided in the sides of a hut.

These may be raised to allow air to enter through screened apertures. Doors and windows should be screened in all habitations.

Cantonments should be heated by stoves large enough to receive a length of cordwood. The quantity of metal in them should be

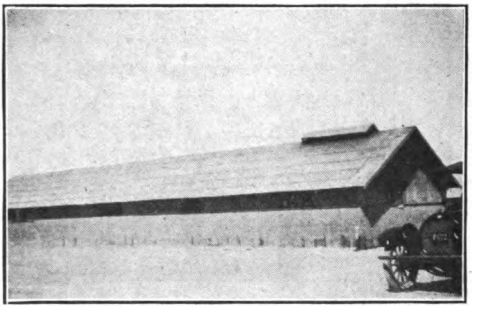

FIG. 13.—Screened kitchen and dining room used on the Mexican border.

large so that they will maintain a relatively steady heat. The output of heat may be made more available by sheet iron drums placed upon their stoves. Combination kitchen and dining room with

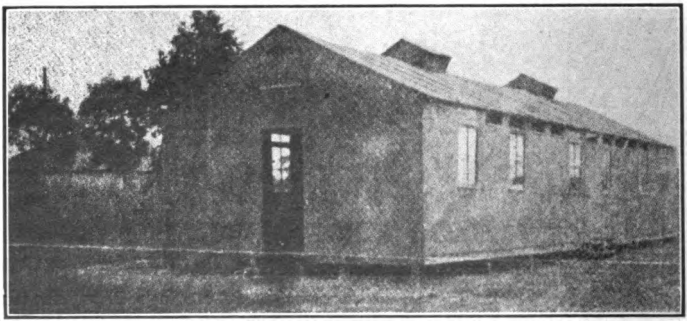

FIG. 14.—Portable hospital hut. (*Austrian service.*)

screened sides which may be closed by panels should be provided for all organizations.

A very important type of shelter which is steadily coming into greater use is the portable hut. It is constructed in sections that

may readily be cleated into position. Its walls and roof are usually made of varnished canvas. Varnished papier maché is also employed. This type of structure, because of its great solidity, is especially valuable in the hospital service at or near the head of the line of communication. The huts usually accommodate from 10 to 20 men. One accommodating the latter number, can be erected in about four hours. Their use appears to be restricted to permanent and semi-permanent camps. The writer has inspected several in

FIG. 15.—Adobe hut.

Galicia and in Servia which had passed through much hard service but which were yet habitable, and more suitable for hospital usage than tentage. Drawbacks to their employment further afield than the line of communication are their weight, bulk, and the time required for their erection and demolition.

In the earlier fixed camps of the Punitive Expedition, after the weather became warm, the troops erected shelters made of brush or brush and mud, about the size and shape of shelter tents. Officers built brush shelters around their tents as a protection against wind and dust. Arbors with tops and three sides made of boughs and

covered with boughs or canvas, or both, were quite the most comfortable habitations available at this time, especially if their floors and walls were dashed with water at intervals. Later more permanent structures were erected. The enlisted men constructed adobe brick walls 3 feet high and on these erected their shelter tents. Doors were added to some of these shacks, and, when the weather became colder, extemporized stoves were installed. In some camps log huts were erected, the interstices chinked with mud. In these a space for ventilation the thickness of the rafters was left between the roof and the walls. Many officers constructed huts of adobe

FIG. 16.—Windbreaks made of brush. Water bag in background.

brick. A common type housing three officers was 13 × 18 feet 7½ feet high in front and 6 feet high in the rear, interior measurements. The roof was supported by beams extending from front to rear and consisted either of wattled boughs covered with mud and silt from the river bed or well tamped adobe on a board base. Usually three windows made of boxes with tops and bottoms removed were provided and shelf room was afforded by boxes built into the walls. Doors and windows were screened but as the cold weather approached the latter were closed with glass or sheets of celluloid. Fireplaces were also installed. A good type provided a place above the fire where an oil can with a faucet could be set into the front wall of the chimney, for heating water. Another device was to

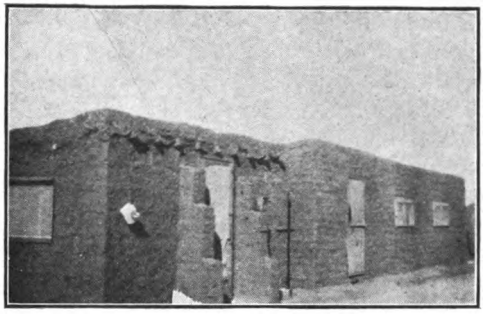

FIG. 17.—Officers' huts.

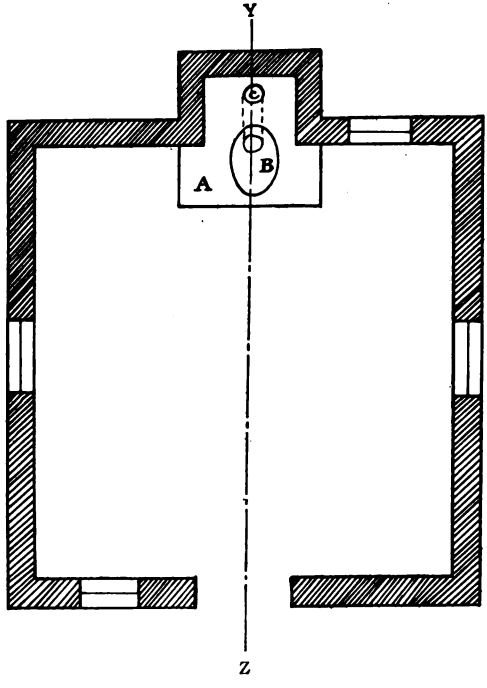

FIG. 18.—Officer's house (designed by Capt. Geo. B. Lake, M. C.). Ground plan. *A*, Hearth; *B*, stove; *C*, chimney. Scale ¼ inch = 1 foot.

insert a cylinder of sheet iron ¼ of its length into the front wall of the chimney, so that it might assist in radiating heat. The use of brasiers was forbidden, two men having been suffocated by the gases which these developed. Another type of building was an elongated adobe structure accommodating 20 men. This type was inadvisable because of the difficulty of ridding it of vermin which were proportionately more easily introduced. The best buildings for barracks were elongated structures divided into four non-communicating rooms, each lodging four men.

Habitations in trenches should be drained to the outside rather than under-drained. Water which accumulates in drains

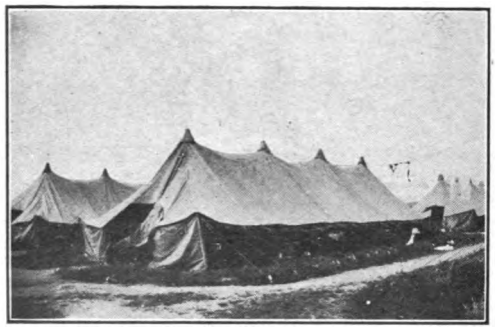

FIG. 19.—Field hospital ward tent.

should be removed periodically by pumps. Walls should be made double and the interspace filled with sand or brushwood. Iron sheathing is incorporated in the earth covering of the gun emplacements.

KITCHENS

Kitchens in the Punitive Expedition were at first protected from the sun by arbors, or tent flies. Coolness under the latter was promoted, if two flys were used by pitching them parallel 6 in. apart. Later, more permanent structures were built of adobe, usually with the kitchen at one end, the mess hall at the other. The combined adobe kitchen store room and mess hall prescribed in the 16th Infantry for each company, measured about 32 feet

square by 7 feet high at the eaves and 11 feet high at the ridge. It was built of adobe and roofed with canvas, and was divided from floor to ridge by a wall. One half constituted the mess hall, the other the store room and kitchen. The wall between the kitchen and mess hall was pierced by two large openings or windows through which the men were served as they filed by. Plans of these kitchens and dining rooms are shown in the diagrams.

The proper preparation of food in the field, the care of food and kitchens are matters of prime importance. The welfare of the command is determined largely by its receipt of adequate nourishment.

FIG. 20.—Brush shelter for kitchen.

The Army Field Range No. 1 complete weighs approximately 264 lbs. with utensils. With the Alamo attachment it is designed to cook for 152 men. On the march the range is ordinarily set up by simply leveling the ground, and by placing the oven and boiling plate side by side so that their doors will be at the same end. The oven should not be banked but sufficient earth should be tamped along the sides and closed ends to prevent the passage of gases beneath. When used for one day only a few shovelfuls of earth are removed from the place to be covered by the boiling plate. If the range is to remain in place for several days a trench should be prepared as shown in the diagram. When the range is set for more than one day in one spot, bake pans should be elevated slightly above the floor by angle irons. If sand or earth be used on the bottom of the oven chamber a hole is soon burned through the

bottom plate. In permanent camps, instead of using a trench, a range may be installed on a brick wall 8 inches thick and three bricks high. The outside of this wall is banked with earth. In permanent camp, garbage may be consumed and fluid evaporated by placing the stove on a pit four feet long, three and one-half

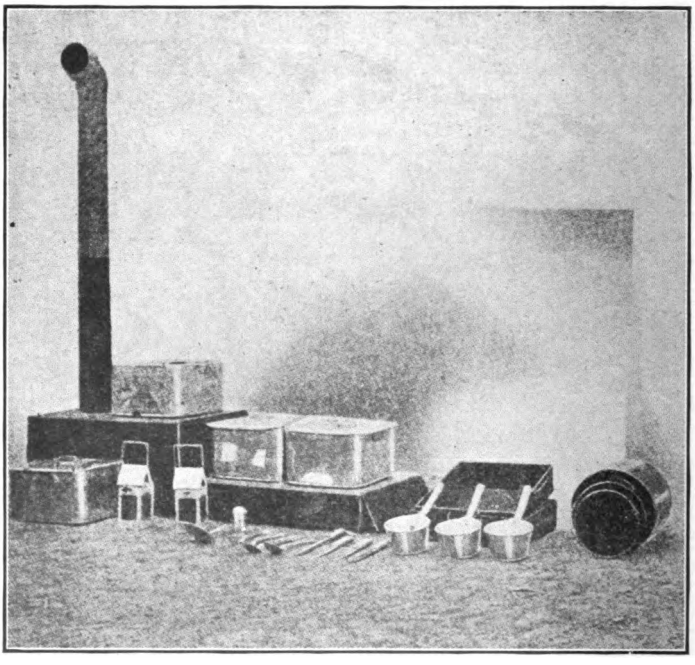

FIG. 21.—Army field range, without Alamo attachment. (*Manual for Army Cooks.*)

feet wide, and one foot deep. This pit is filled with rocks. Liquid refuse is poured through a chute to the bottom of the pit, and garbage is burned on the fire.

The present regulations provide for the use of equipments "A," "B" and "C" in the field. The first is used in campaign, the second in mobilization or concentration camps and the third in permanent camps. Equipment "A" provides quite limited kitchen facilities

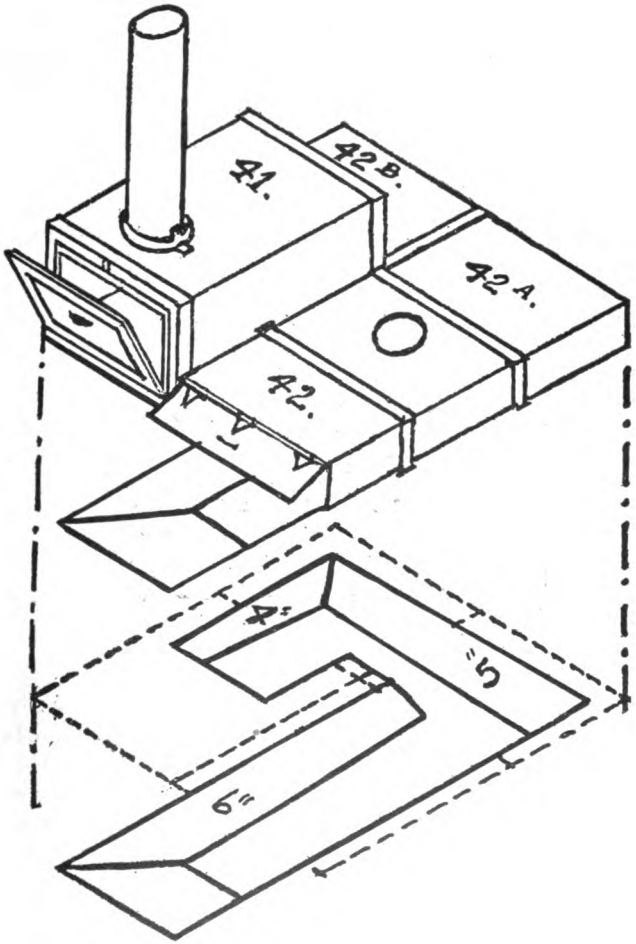

FIG. 22.—Upper figure shows army field range No. 1 with Alamo attachment, assembled for use. In the lower figure the solid lines show trenching for same and the dotted lines the trace of the base of the oven, boiling plate and Alamo attachment. (*Manual for Army Cooks.*)

but these are adequate for protracted periods. The Punitive Expedition used it with but few additions for 10 months. Its evolution of cooking facilities when in fixed camp is indicated in the appended photographs and diagrams. At first the fire was built over a trench filled with stones and crossed from end to end by a horizontal iron bar. From this depended hooks or wires to which horseshoes were fastened to act as hooks for cooking vessels. Oil cans were often used for boiling. Baking was done in a pan supported over a fire on four tin cans or stones and covered by coals upon a sheet of tin. The next device was a fire pit one foot deep filled with rocks not less than four inches in diameter. It was

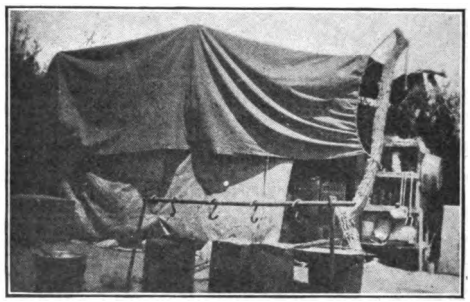

FIG. 23.—Equipment "A" oil cans used as receptacles.

surrounded on three sides with walls nine inches high and eight inches wide, close enough together to support bakepans, there being at first no metal available for supports. Liquids were poured into the bottom of this pit through a tube made of tin cans, the upper one of which was removable. Its bottom was perforated to act as a strainer.

In a later type an oven was erected over one end of the fire pit a draft being provided either by a chimney or a hole left in the end wall. In some ovens a second fire was used to heat the top of the oven and to boil water. Detached ovens with either one or two chambers were also evolved. The best type of cooking apparatus finally developed consisted of parallel adobe walls supporting transverse rods supporting vessels on which meat and vegetables were boiled. Heat from this trench was carried under, back of, and over an oven

FIG. 24.—Evolution of cooking facilities in the Punitive Expedition

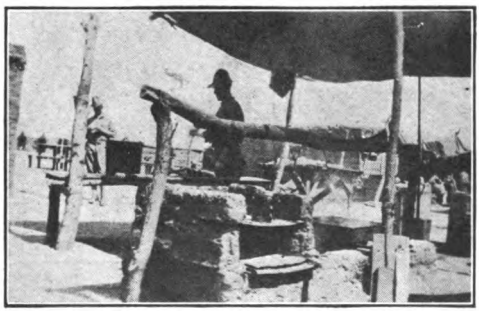

FIG. 25.—Evolution of cooking facilities in the Punitive Expedition.

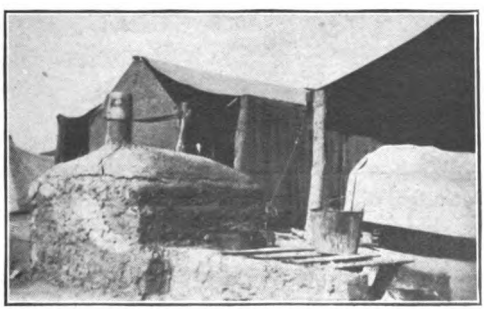

FIG. 26.—Evolution of cooking facilities in the Punitive Expedition.

chamber, as shown in the diagram, to emerge up a chimney at the front near the fire pit. In some cases the chimney was at the back and the column of heated air divided to pass over and under the

FIG. 27.—Evolution of cooking facilities in the Punitive Expedition.

FIG. 28.—Evolution of cooking facilities in the Punitive Expedition. Bake oven.

oven chamber. The advantages of the combined oven and kitchen pit were that one fire was adequate for general cooking, baking, and incineration. The oven was constructed as follows: Two

parallel trenches were dug the width between them being that of the fire box. An end trench was also dug. These trenches were filled with adobe mud and on this walls were erected eight inches thick. When a suitable height for a fire box was reached (about twelve inches), strips of iron, heavy wire, etc., were laid across the walls and the space between them. These supported the top of the fire

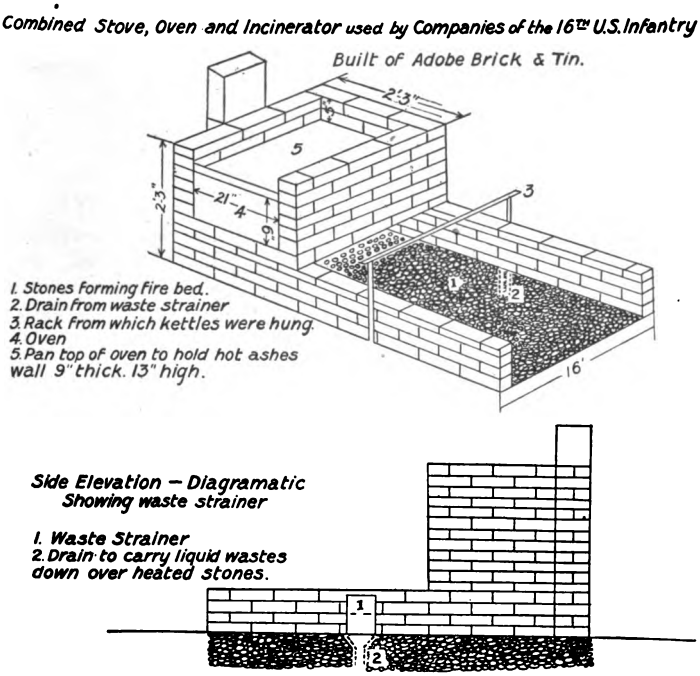

FIG. 29.—Combined stove, oven and incinerator. (*After Hefflebower.*)

box and on them the floor of the oven was built. It consisted of a layer of iron, or tin, a layer of sand about an inch thick, and a second layer of sheet iron or tin. The walls including those of the oven were then continued upward until the desired height of the oven was reached. Pieces of iron or heavy wire were then laid across the top of the oven and its top was covered by a sheet of tin

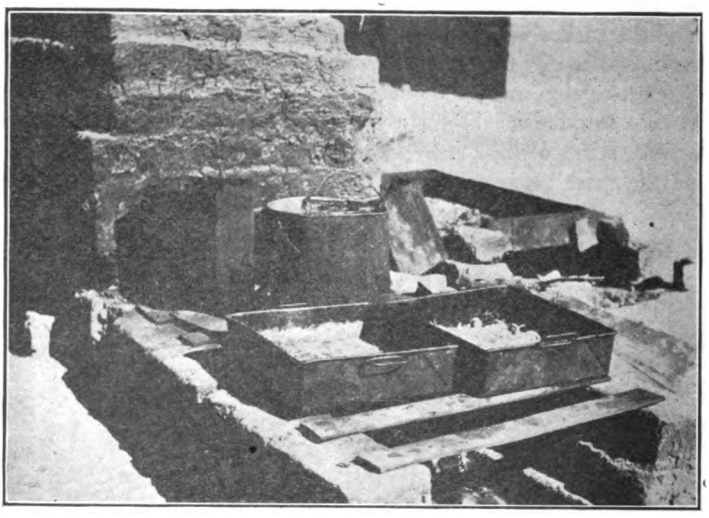

FIG. 30.—Combined range and oven. Door of oven at left (*Demmer.*)

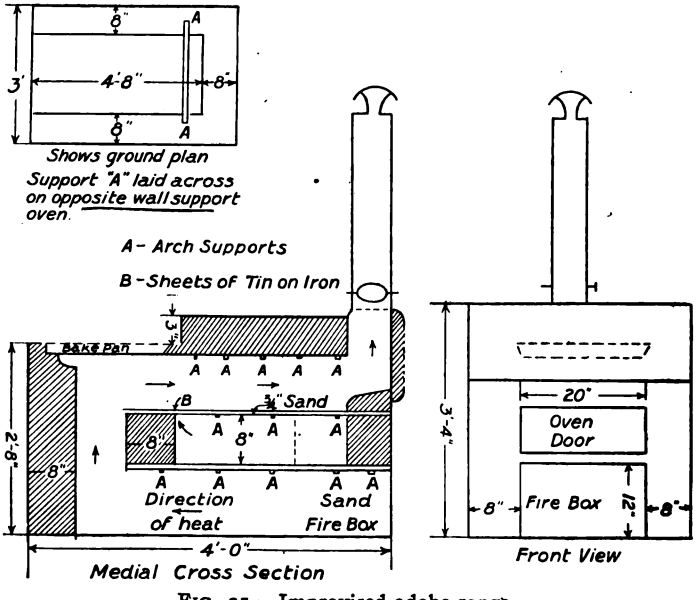

FIG. 31.—Improvised adobe range.

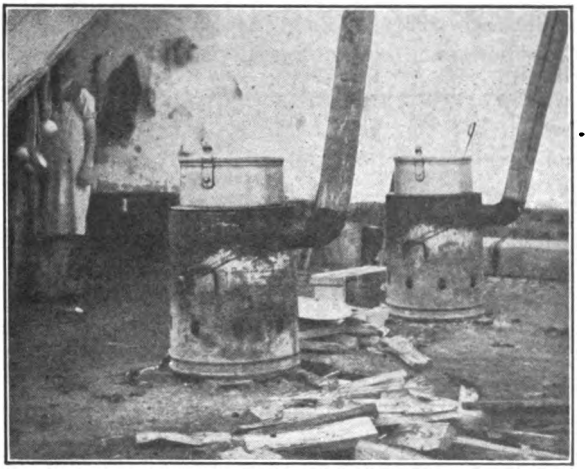

FIG. 32.—Austrian field cooking kettles.

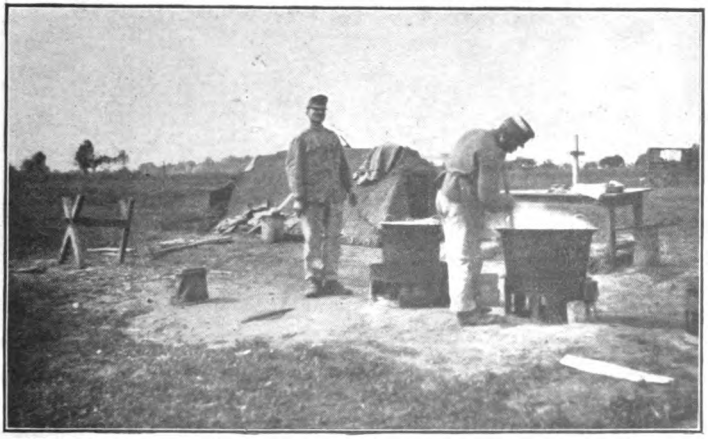

FIG. 33.—Austrian field cooking kettles.

or iron supporting about a quarter of an inch of sand. The outside walls were then completed and the bake pan set in position in the top. The bottom of this pan was supported by the outer wall and

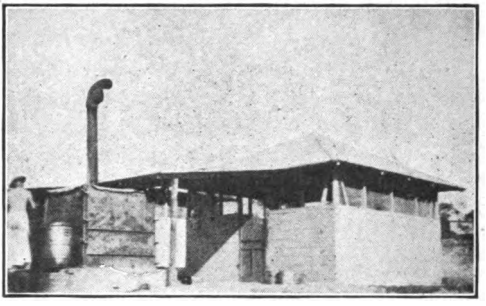

FIG. 34.—Field oven (American).

FIG. 35.—Wheeled field oven (Austrian) with tent.

in direct contact with the heat passing over the top of the oven. An outlet was provided and a chimney arranged. An opening was left at one end for the fire box, at the front of the oven, and one on the

side for the oven chamber. The structure was then covered with a thick layer of adobe (Fig. 31).

The material for stove pipes, top and floor of oven was obtained from hardtack boxes or oil cans. Often the chimney was made of adobe. The strips of iron used in making arches to support this chimney or to shape the oven chamber were obtained from discarded wagon tires, auto truck springs, etc. Sand was found preferable to any other substance for use in making the bottom and top of the oven. Such an oven can cook 150 loaves of excellent bread daily. Its output in other respects was said to at least equal that of the army range.

Rolling Kitchens.—Rolling kitchens have long been in use in European armies and have proven their value under European

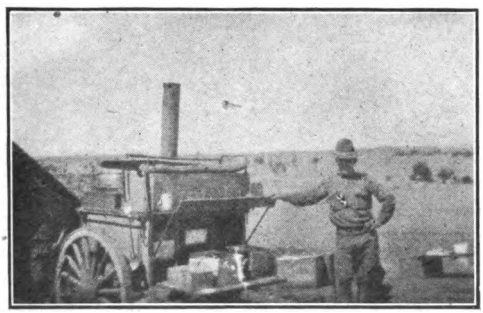

FIG. 36.—Rolling kitchen in Punitive Expedition.

conditions of warfare. They are indispensable in trench warfare. Different types are in use in the several armies. The most generally satisfactory one consists of two main portions, which are connected in much the same manner as a cannon and limber. The forward section carries supplies of small articles, spices, sugar, etc., and kitchen utensils. The rear section, in which cooking is done, is provided with three boilers (in the later types) each containing about 25 gallons. These are suspended from the circular plate which forms the top of the fire box. This plate may be revolved so that each boiler in succession may be heated. Usually food is cooked in two receptacles and coffee or tea boiled in the third.

There are certain other refinements in the latest models for baking, etc. One of these kitchens is adequate for 250 men.

The advantages of the rolling kitchen are the following:

It uses a small amount of fuel, can keep up with the troops, have hot food ready on arrival in camp, can be driven forward to the trenches after nightfall to supply hot food with a minimum of inconvenience, conserves all the nutriment of the food stuffs cooked, and, by providing tea or coffee reduces the temptation to drink polluted water.

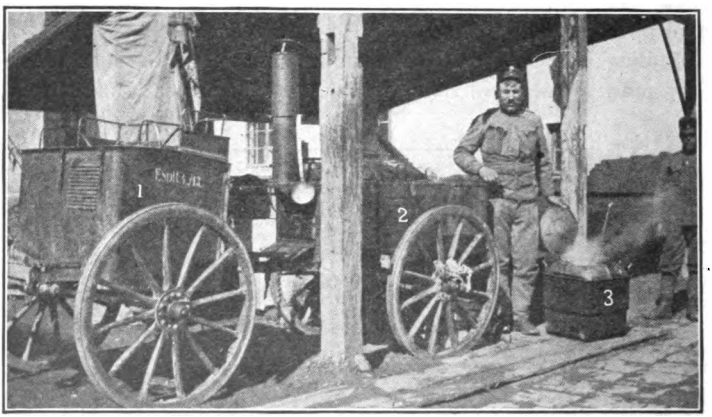

FIG. 37.—Wheeled kitchen, Austrian army. 1. Limber, containing cooking utensils, etc. and affording driver's seat. 2. Cooking chamber accommodating 3 kettles. 3. Kettle removed from its socket in lid of cooking chamber.

Usually the rolling kitchen is accompanied by a wagon which carries beef, flour, bread and other bulky food supplies, together with forage for the animals. The rolling kitchen used in the Punitive Expedition proved too cumbersome for that service. These vehicles will not be well regarded in the U. S. Army generally until the troops come to rely almost exclusively upon boiling for the preparation of their foodstuffs other than bread.

Small commands especially can utilize in the field the principle of the fireless cooker. Food is boiled for about half an hour, the length of time for such preparation varying with different articles

and with the efficiency of the fireless cooker employed (see Manual for Army Cooks, page 124). It is then placed in a closed receptacle in which heat is conserved by a surrounding box packed with straw or other non-conducting material. In the Austrian service independent commands of 25 men are each supplied a rectangular fireless cooker, made of nickeled steel, having a capacity of 25 liters. It is provided with a screw lid and is carried packed in a corrugated sheet iron container. This in turn is enclosed in an asbestos lined box. The container is removable and demountable and can be used as a grate when the food is being boiled in the cooker.

Kitchen Refuse.—In very temporary camps kitchen refuse is thrown into pits near the kitchens. Solids, including tin cans, are

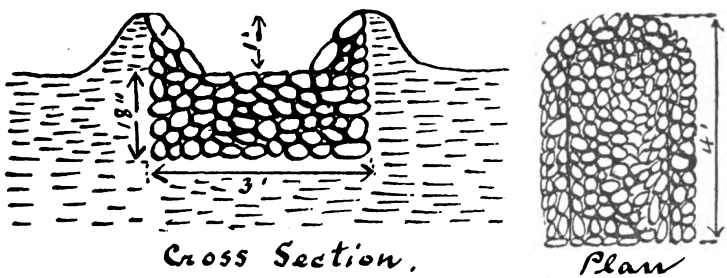

FIG. 38.—Rock pit kitchen incinerator. This incinerator is not essentially different from the type in use in the U. S. Army for several years. (*Lewis and Miller.*)

passed through the fire. The refuse is covered daily and these pits are filled in before the command moves. In more permanent camps the following devices may be employed.

The rock pit incinerator consists of a pit 12 inches deep, 4 feet long, and 3 feet wide filled with stones not less than 4 inches in diameter. The walls are carried up 6 inches above the surface on three sides. One end is left open.

The Guthrie incinerator is about 8 feet long, 2 feet high, and is made of bricks laid in cement which are later banked up with earth. One end is open, the other closed. Over the closed end is erected a Sibley stove or better a length of 6 inch tile pipe or a chimney 6 inches square, internal measure. The walls support an

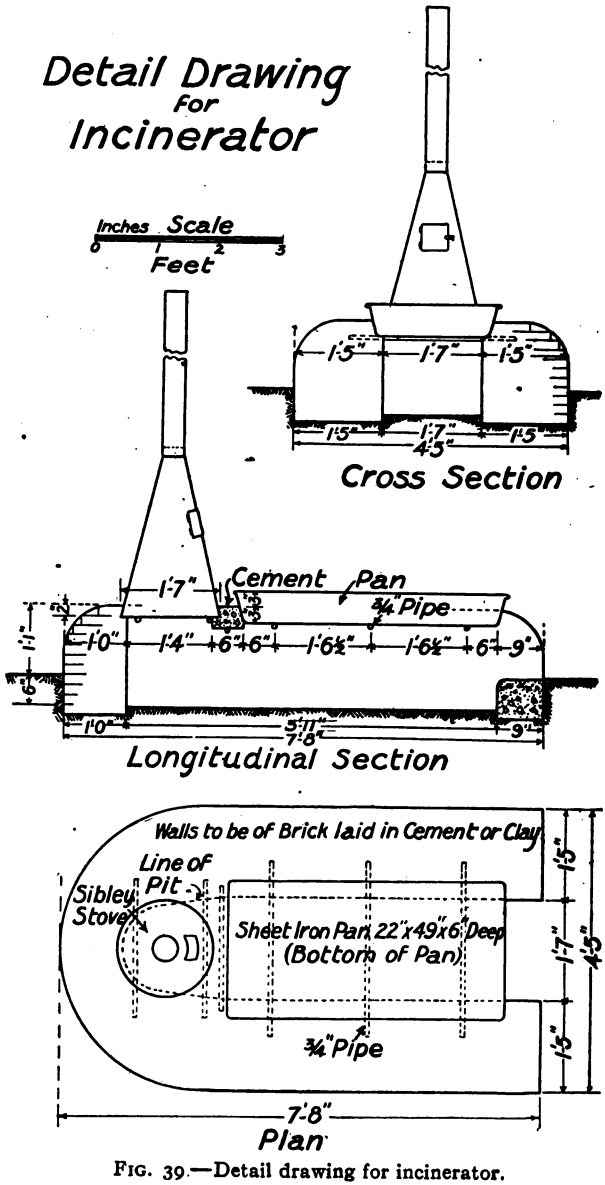

FIG. 39.—Detail drawing for incinerator.

evaporating pan made of sheet iron about 4 feet long, 20 inches wide, and 6 inches deep. An over-flow hole is provided near the top at one end. This pan may be near the chimney or if an open space is left between the two this should be crossed by iron bars on which solid garbage may be dried. A piece of sheet iron on the bars will increase the draught. The rock pit and Guthrie incinerators are thus discussed by Lewis and Miller.

"**Rock Pit Incinerator.**"—*Advantages*—(*a*) Where stone is available the construction is simple, quickly carried out and inexpensive. (*b*) Its use in mobilization and concentration camps trains the

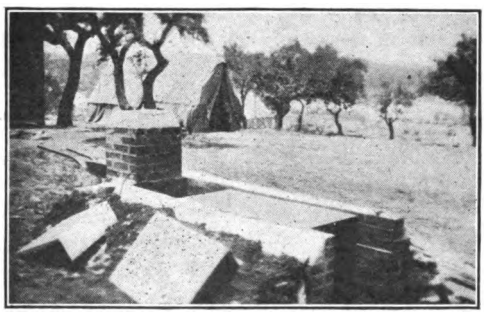

FIG. 40.—Guthrie's incinerator.

troops in a method which will probably be available for such use under all conditions of service. *Disadvantages:* (*a*) Requires a very considerable amount of time and patience in its operation, as the liquid must be added to it in small quantities at a time. (*b*) The interstices between the stones soon become clogged with ashes necessitating the reconstruction of the incinerator. (*c*) Owing to the time and trouble involved in adding the liquid garbage, there is great temptation for the cooks and kitchen police to dispose of dish water by throwing it in the company street, or some other unauthorized place. (*d*) If the sides of the incinerator are banked up with earth which is not thoroughly packed and hard, they afford an exceptionally favorable breeding ground for flies. (*e*) When this type of incinerator is unused for a period of more than ten days, as may happen when the company goes on outpost duty or to the

target range, flies may breed in the pit itself. Porosity of the soil has much influence upon the value of the rock pit incinerator.

"**The Guthrie Incinerator.**—*Advantages.*—(*a*) With the occasional renewal of the evaporating pan the same incinerator may be used indefinitely. (*b*) The liquid may be added in considerable quantity at a time, which does away with the temptation to dispose of liquid garbage surreptitiously. *Disadvantages:* (*a*) The material for its construction costs in the neighborhood of $20. (*b*) The experience gained in its operation is of little value in the training of troops for active service. (*c*) If the evaporating pan is not thoroughly scraped and cleaned every day a thick crust soon forms on the bottom of the pan, which results in a largely increased consumption of wood and in the destruction of the pan. (*d*) The draft is not sufficient, but this may be corrected by substituting a 6-inch tile pipe for the Sibley stove.

"It has been the writers' observation that any of these incinerators will dispose of the liquid and solid garbage of an organization provided they are intelligently managed. They are, however, expensive to operate where wood costs as much as it does on the Mexican border. For batteries of artillery and other large organizations the allowance of wood, as given in Equipment Tables, Quartermaster Supplies, is insufficient. In the El Paso district an increase of ½ cord a day for each incinerator was recommended and authorized. In our opinion the rock pit incinerator is the incinerator of choice for all camps not provided with sewer connection. Economy of construction and the training derived from its use are of so much importance that they outweigh the disadvantages referred to above. We believe, however, that as much as possible of the garbage of an organization should be consumed by the same fire that is used in the preparation of the food. To accomplish this purpose we recommend that a pit, a little larger than the fire box, 1 foot to 18 inches deep and filled with stones less than 4 inches in diameter, be provided under each field range. The liquid is preferably added by pouring it through an improvised funnel attached to a tube which terminates at the bottom of the pit. This tube may be constructed of one or two joints of stove pipe or from tin cans. Care should be taken however to prevent flooding the fire. Solid garbage should only be added when the range is not in active use for other purposes. If

carefully managed and kept free from ashes this pit will consume the greater portion of the kitchen waste, making it necessary to use the outside incinerator for only a short time each day, possibly only when the use of some particular article of food makes an extra amount of waste.

"If the Guthrie type of incinerator is used, it is especially important that an overflow hole in the end of the pan be provided. This was not done in the incinerators furnished in the El Paso district with the result that the pans were continually boiling over and polluting

FIG. 41.—Adobe incinerator.

the ground in their immediate vicinity. The cross bars in front of the pan on the new model Guthrie incinerator are evidently intended to provide a p'ace to boil water for washing mess tins. By lacing them with baled hay wire, they may be used as a grate upon which to dry solid garbage preparatory to placing it on the fire. In our opinion this is the best use to which these bars may be put." (Lewis and Miller.)

Various types of incinerators were developed in Mexico. One of these was made of mud walls 3 feet long, 2 feet wide and 2 feet high. It was closed at one end and covered with puddled clay. At the other end it was closed by two doors, one above and one below

the grate on which garbage was dried. A chimney removed the gases and provided draft. A rock pit under it evaporated liquids. Another new popular type was similar to the rock pit incinerator but its walls were higher and it was crossed by a grate.

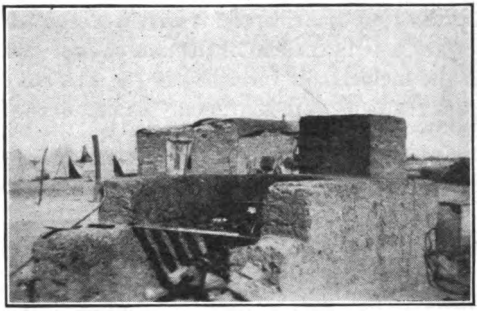

FIG. 42.—Adobe incinerator. (Popular type in Punitive Expedition.)

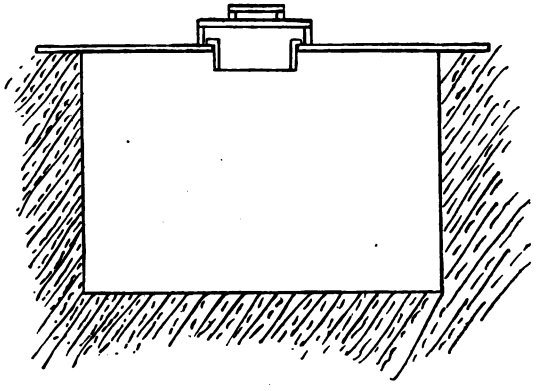

FIG. 43.—Kitchen soakage pit. (*Manual for Army Cooks.*)

When the wood supply is scant, waste water may be disposed of in pits, but this practice is avoided if possible. Such pits are usually about 5 feet square and 4 or 5 feet deep. The sides and bottom are well broken with a pick. They are covered with boards, or, if this be lacking, by boughs covered with earth. A hole is left in the top to receive a snugly fitting, removable box. This has a removable top

and a screened bottom made of burlap or mosquito net. The object of this is to strain out the fats which would quickly prevent absorption of liquid by the soil. The value of the strainer is increased if the bottom be covered with two layers of burlap and over this there be an inch or two of sand. The addition of 5 grains of alum to the

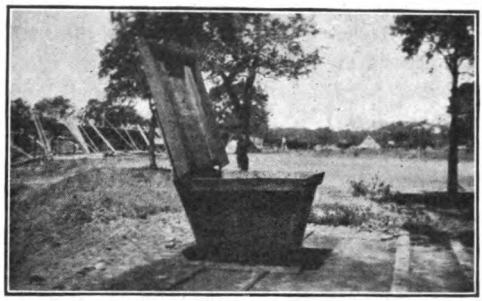

FIG. 44.—Hopper in cover of pit for reception of liquid garbage. It contains a removable burlap sack supported by upturned nails acting as hooks.

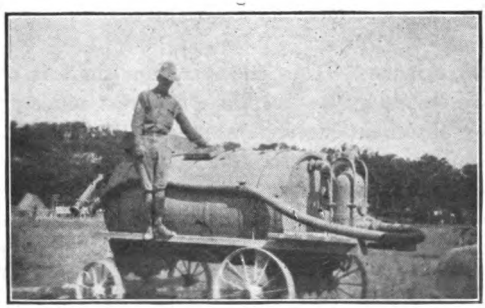

FIG. 45.—Excavator wagon and pump, best type. The wagon should carry the pump. Utilized to remove liquid waste from kitchens to septic tank.

first gallon of fluid would form a flocculent precipitate which would impede the passage of fine particles of refuse. Solids and fats arrested are removed and burned on the fire; liquid is usually absorbed by the soil but may be removed by an odorless excavator. From time to time the sand must be renewed especially if alum

be used. Liquids collected in cans or covered pits near kitchens may be removed by an odorless excavator to a communal pit several hundred yards from camp. In this septic action occurs. Such a pit may be used for several weeks depending on its size and the porosity of the soil. Flies do not breed in it until the margins are saturated. The pit is then filled with water to drown the larvæ and it is later filled in. Such a pit may be divided into compartments like a grease trap.

Grease Traps.—A grease trap used in the English service is made by dividing a box into two compartments by a vertical partition which does not quite reach to the floor. It leaves an interval about an inch high. The box is filled with sand to a depth of

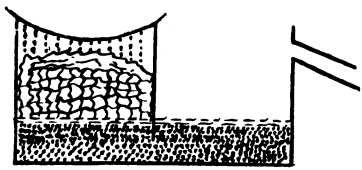

FIG. 46.—Grease trap.

two or three inches. The side receiving fluid is covered with a removable colander-like receptacle to arrest solids. It may also contain any absorbent material which will arrest fats and may be removed and burned. Waste water will be freed from fat, as it passes through the sand and under the partition, up into the second compartment so that it can be absorbed by the soil. It escapes from the box through a notch in its side or a pipe and goes off through a ditch. It may first be passed through settling tanks before it enters the ditch. Another device is to employ a half barrel as a separating tank. Grease rises and is skimmed away, the fluids are syphoned off. Precipitation of small particles of solids other than fats can be accelerated by alum five grains to the gallon.

Another type of grease trap is the following:

A pit is dug 3 foot cube, with a surface trench leading into it 5 feet long and 9 inches wide and deep. At the end farthest from the pit is a tin containing hay, with an outlet in the bottom, leading into the pit. Inside this tin is another containing hay, tea

STRAINER GREASE TRAP AND SOAKAGE PITS FOR SULLAGE WATER.

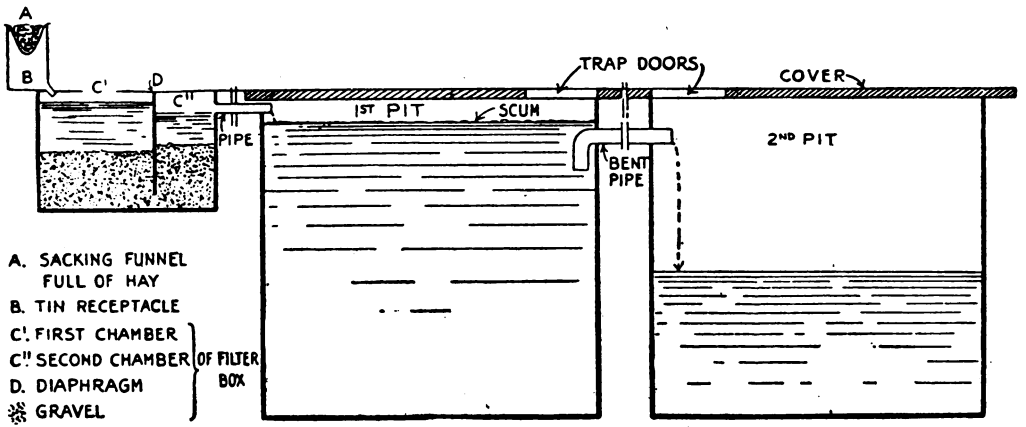

FIG. 47.—Grease trap suitable for absorbent soils. Burn hay daily, renew sacking frequently, scrape sand daily, renew every two weeks and scrape sides of pits as required, cover tops with earth. (*After Lelean.*)

leaves or sawdust. The trench is lined with tin and filled with brick or coke in the size of walnuts. Both pit and trench are covered. Grease is arrested so that clear water flows into the pit. The brick or coke is removed and burned free of grease every other day and replaced. Hay, etc., are burned and replaced.

A modification similar to the grease pit just described above is to provide a box 4 feet long, 2 feet wide and 3 feet deep. A partition 8 inches from one end reaches to within 3 inches of the bottom.

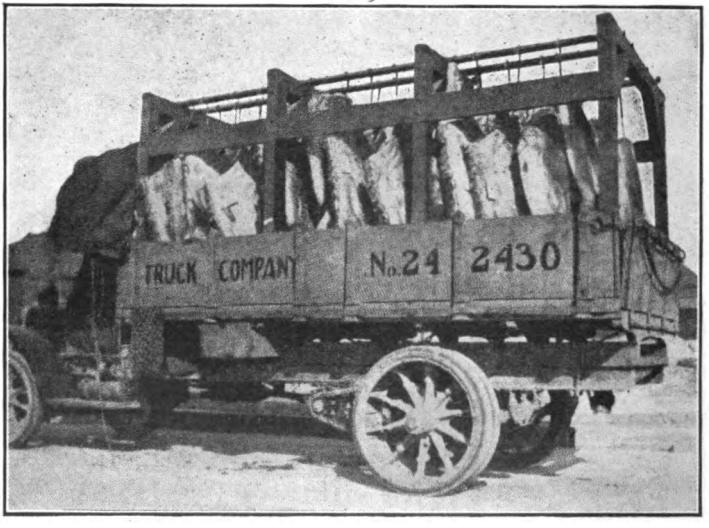

FIG. 48.—Meat wagon devised by Truby and Furlough. In actual use the framework is enclosed in a tightly fitting canvas cover. (*Lewis and Miller.*)

The whole box is then filled from below upward with 12 inches of broken brick, walnut size, 6 inches broken brick, pea size, 3 inches of sand and a covering of hay. Water percolates down and up to the outlet and runs into a soakage pit. The hay is burnt daily and sand removed and replaced at frequent intervals.

Care of Food Stuffs.—Supplies should be protected from sun, flies and dust, both before and after issue to kitchens. Wagons hauling supplies should be freshly cleaned. Meats should be

covered with cloths which are washed daily. For the delivery of meat to large camps, a covered auto truck equipped with iron uprights and cross bars from which the meat is hung, is very de-

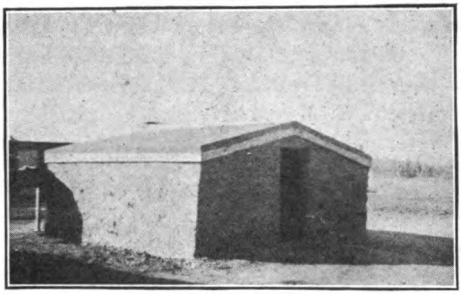

FIG. 49.—Adobe meat house, Dublan.

FIG. 50.—Adobe meat safe.

sirable. A screened meat house should be provided if delivery does not occur direct from abattoirs or packing houses to companies. There should be a daily inspection of fresh meat, bread and vegetables of at least one prepared meal and of kitchen apparatus,

especially water containers, the meat saw, meat grinder, and dish cloths.

Certain expedients are extemporized for comfort and for preservation of food in camp. Meat may be protected by each company in a safe, built of bricks, burlap or net, door and windows being closed by burlap or mosquito netting. Garcia's meat safe is a truncated pyramid covered with double burlap. It supports a water-filled oil can with a perforated base. The meat safe is kept cool by the evaporation of the water as it trickles down its sides. A small safe for

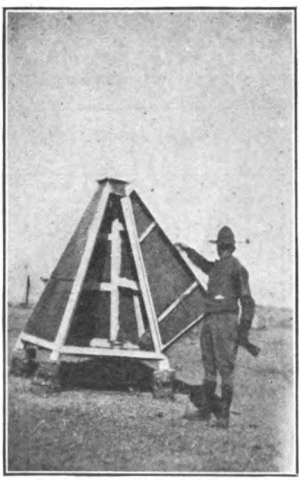

FIG. 51.—Garcia's burlap meat safe.

fruits, milk, etc., is cooled by evaporation from an oya set in a hole in the top of the safe. An ice box and a swinging cage may be made as indicated in the enclosed illustrations from the Manual for Army Cooks. Dining tables should be made of 1 × 12-inch material with the middle board removable so that vertical surfaces may be cleaned. Kitchen table tops should be made of 2 × 6-inch material, five boards wide. Cracks should be close, the second and fourth boards left unnailed, so that by lifting the loose boards all exposed surfaces may be scrubbed without trouble. On no account should kitchen or mess tables be constructed of tongued and grooved lumber. A

mess table may be extemporized by digging a circular or rectangular trench one foot deep, throwing up the earth to the center and leveling off. Water coolers may be made by inserting a faucet in a vinegar barrel, with removable top.

The kitchen floor should be wet down daily, sprinkled with lime or ashes, and places where flies collect should be burned over. If these insects abound, kitchen and mess tents should be burned out

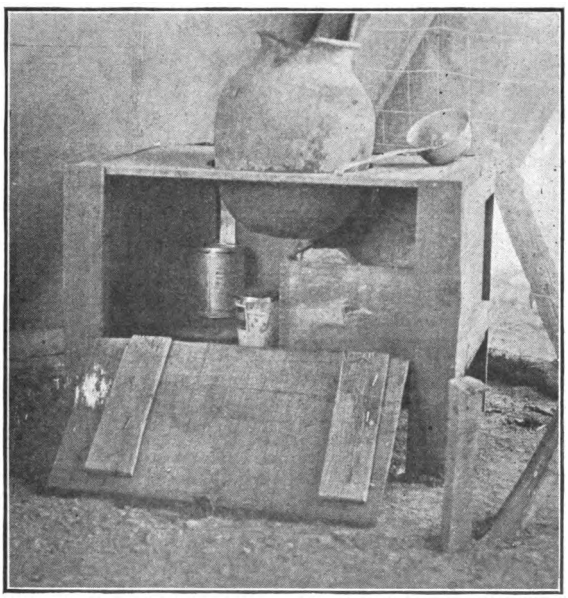

FIG. 52.—Chest cooled by porous water jar.

nightly with torches made by fastening tin cans to sticks and filling these with oil and inserting burlap to act as wicks. A torch may be made by simply wrapping burlap on the end of a stick with wire and soaking it with oil.

Flies.—Prevalence of flies should be prevented by destroying their breeding places. Their abundance is inversely proportionate to the efficiency of camp police. They multiply especially in manure, in latrines that have been neglected and in the soil near neglected incinerators which is kept warm by the fire and moist by

fluid that has not evaporated. Prevention of breeding in manure is discussed later.

For the destruction of flies, traps, fly paper and swatters are employed. If these insects are numerous, it is the practice in some commands to exercise the entire organization for half an hour daily with fly swatters. Fly paper may be made by heating together five parts of castor oil and eight parts of resin by weight until it is stringy when cool, and painting on glazed paper. The mixture

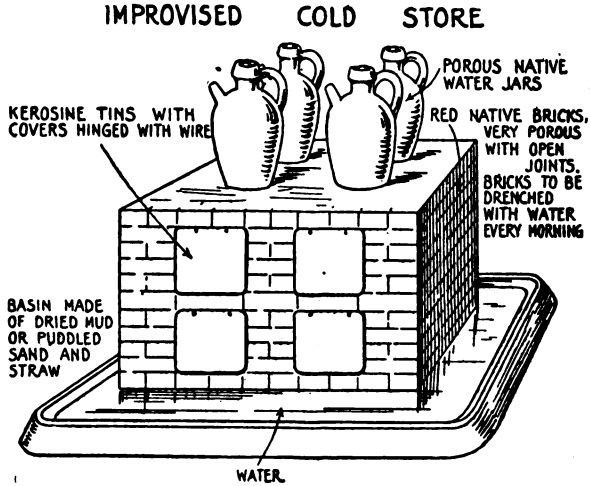
IMPROVISED COLD STORE
POROUS NATIVE WATER JARS
KEROSINE TINS WITH COVERS HINGED WITH WIRE
RED NATIVE BRICKS, VERY POROUS WITH OPEN JOINTS. BRICKS TO BE DRENCHED WITH WATER EVERY MORNING
BASIN MADE OF DRIED MUD OR PUDDLED SAND AND STRAW
WATER

FIG. 53.—Brick box cooled by evaporation. The interior should be sterilized before use and weekly thereafter. (*After Lelean.*)

should not be brought to the boiling point. The fly paper is hung to advantage from the ridges of cook tents, or the mixture may be painted on wires which are hung into latrines or stretched across mess tents. Fly traps are usually made of wire net, are about two feet six inches long, one foot wide and sixteen inches high. There is provided a re-entrant prism also made of net which should be nailed at its base to the sidebars of the frame so that it covers the trap's entire area, less the thickness of the wood strips. This prism should be about eight inches high and its sides should slope to give an angle of between 70 and 80 degrees at the ridge. Apertures not more than

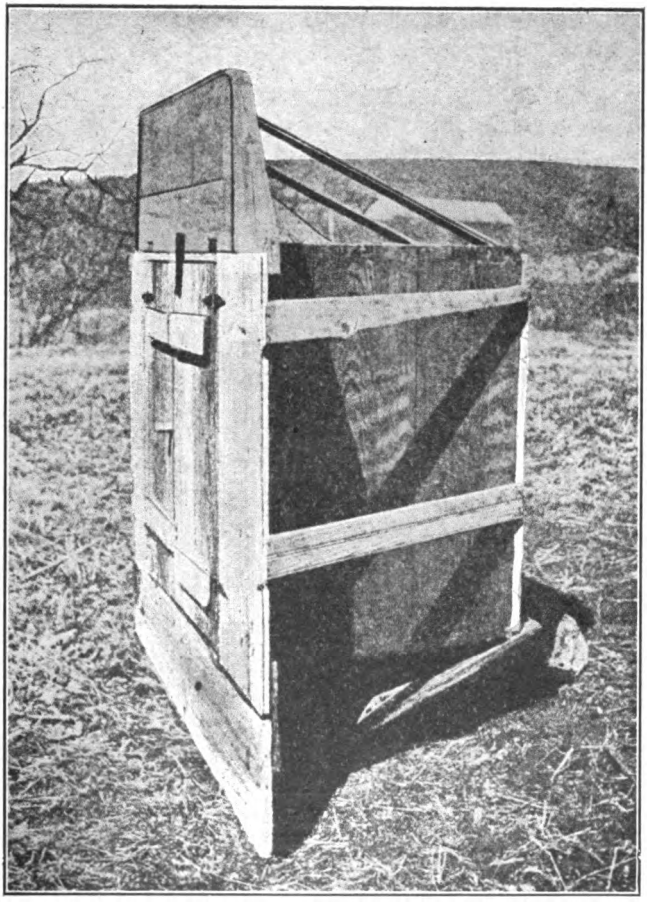

FIG. 54.—Field ice box. It can be readily constructed according top above design. It should be well banked with earth on sides, rear, and top and should face north. (*Manual for Army Cooks.*)

½ inch in diameter should be made by forcing the threads of the wire apart and not by cutting it. They should be about two inches apart. When no wood is available for frames the traps are made in a generally cylindrical shape, closed up the side and along the top by

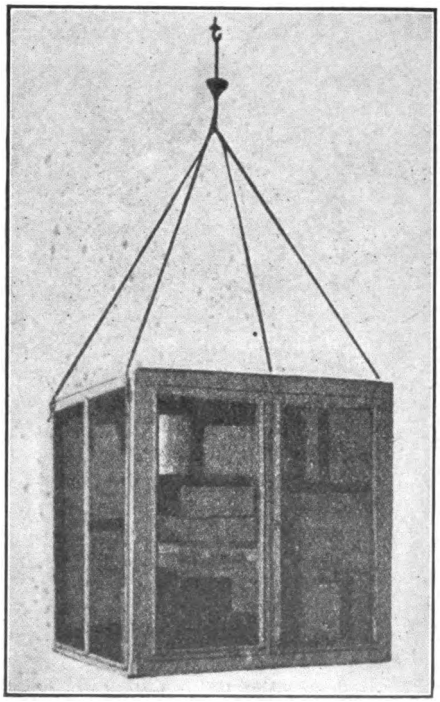

FIG. 55.—Swinging cage. Especially useful in the tropics and in camp. It should be suspended in a manner that a cup of oil placed as shown will prevent insects from reaching the cage. Dimensions about 3 feet cube. (*Manual for Army Cooks.*)

wire from hay bales. The legs of traps should be not more than one inch long. Traps may also be made of kegs, boxes, tin cans, etc., by removing tops and bottoms and leaving short projections to act as legs. The top is covered with net and the bottom provided with a re-entrant cone, prism, or pyramid of wire net.

The English employ in Egypt much larger fly traps some of which are 6 feet square and 8 feet high. These all employ a platform which extends beyond the trap so that it may support small sloping shelves which afford a lighting place for the insects. These enter

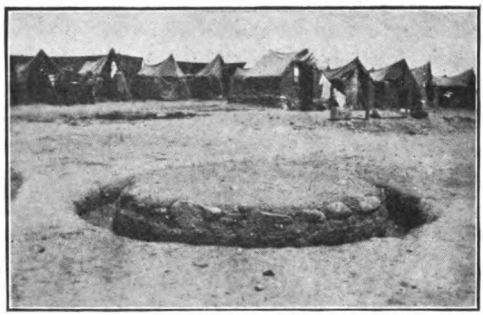

FIG. 56.—Dining table.

through a narrow slit provided between the walls of the cage and the alighting boards.

Traps should be baited at regular intervals. This is important but usually is neglected. Excellent baits are beer, a mixture of cheap molasses and water, brown sugar one part and water four parts, banana and milk, a paste made of peas or a mixture of brown

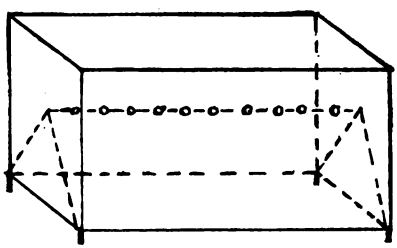

FIG. 57.—Diagram of fly trap.

sugar, cheese and water that has been standing for a few days, etc. Truby had excellent results in the El Paso District with a bait made of potato water, bran, yeast and brown sugar. It fermented in about 24 hours and remained serviceable indefinitely, so long as it

was kept moist. Whatever fly bait is employed it should not be of the same material as other food that flies have free access to.

An excellent fly trap is that devised by Ober. Lieutenant Ober describes his trap as follows:

"Two triangles are marked out on any scraps of board 10 or 12 inches wide by 1 foot or more long, and ½ to ¾-inch holes are bored through at the three angles (*b*, *c*, *d*) ½ inch from the edges. This is done before the triangular pieces are sawed out, to prevent splitting while sawing.

"A triangular piece (*A*) is cut out of the base of each triangle, its base extending to within 1½ inches of the sides, and is so

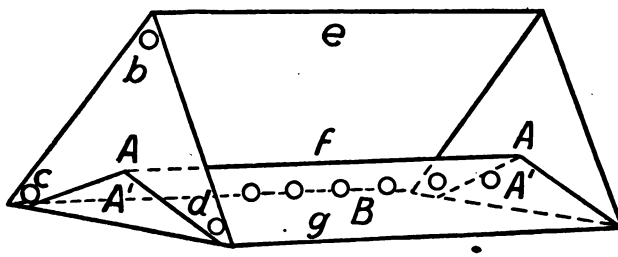

FIG. 58.—Ober's fly trap.

marked that it can be readily replaced in the position it occupied before cutting. These large triangular pieces, together with their respective smaller pieces, form the ends of the fly trap.

"Then cut three strips of inch board (*e*, *f*, *g*) 1 to 1½ inches wide, as long as the wire screening is wide, and securely fit them into the holes (*b*, *c*, *d*). This forms the frame around which the screening is placed and securely tacked to the edges of the larger triangular pieces, beginning at the top of the frame. At the base the screening is tacked to the sides and apices of the small triangular pieces which are then returned to their respective places, thus forming a triangular space *B* beneath the trap, in which the bait is placed. One of these triangles may be permanently nailed, or held in place by small ¼ to ½-inch thick thumb-button latches; the other piece is to be held in place by thumb-screw buttons or screws so that it may be readily removed, the attached screening slightly lowered and the flies

promptly spilled out; after which this piece can be replaced, secured, and the trap is again ready for use. If nails and screws are used to fasten the small triangular pieces, tack a ½-inch thick strip to their bases to elevate the trap so the flies can get under to the bait which should be placed beneath the triangular screened space *B* in the bottom of the trap.

"After fastening the small triangular pieces in place the first time and smoothing the sides of the triangular space then formed by the screening, small holes, 1 to 2 inches apart, should be made through the screening in the apex of the triangular space, by any instrument capable of making a hole the size of a lead pencil or a little larger, through which to allow flies to enter the trap."

Poisoned fly baits may be used. Such are a solution of formalin in milk, sugar and water, or in water only, 4 ounces to the quart, or a solution made by dissolving one pound of sodium arsenite in boiling water and adding to this a ten per cent. solution of brown sugar in 10 gallons of water. Poisoned baits should be placed in shallow dishes containing crusts of bread which will afford lighting places for the insects, and kept moist with the solution.

Cockroaches.—Cockroaches around a kitchen may be destroyed by dusting the floor with sodium fluoride, either pure or diluted one half with flour or gypsum. Other useful powders are borax, either pure or mixed with pulverized chocolate in the proportion of one to three, and pyrethrum. A sweetened flour paste containing two per cent. of phosphorous to 98 of glucose and flour is used. Pyrethrum, if of good quality is an excellent agent in closed rooms or tents, against flies, cockroaches, fleas and other insects.

Kitchen Service.—Foods should be prepared and served in a cleanly manner. Cooks should be clean and neat in appearance and at all times their equipments and kitchens should be clean. Men suffering from venereal or gastro-intestinal disease should be relieved from duty in the kitchen. Troops should be instructed to clean their mess utensils carefully after each meal and for that purpose a supply of soapy water and another of clean water should be kept boiling at meal times. Men should clean their utensils in the former and rinse them in the latter. Unless the

water is kept boiling, it will be chilled by the first utensils used and be of little use to those who come later. The keeping of uneaten portions of food in tents employed as habitations should be prohibited.

Ptomaine poisoning may be caused by left over cooked meat kept too long or left uncovered, fish in which decomposition has begun, hash made of potatoes and meat not put in the ice box or put into a rapidly cooling oven for protection, and soiled utensils, particularly the meat grinder, on which a certain amount of food may remain after use to decompose and infect the next meat on which it is used.

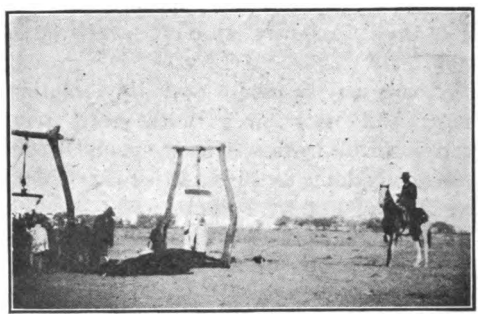

FIG. 59.—Abattoir. Dublan, Mexico.

If the meat used in camp comes from a slaughter house under its supervision this should be inspected daily, at least after each period of usage and kept rigorously clean. No carcass should be accepted without the approval of a veterinary surgeon. Refuse and offal should be buried.

Refuse from the kitchen should be removed regularly at a stated hour daily. As a rule most of this is burned in the fire, but there is always an incombustible residue which should be passed through the fire and removed to the dump.

No hucksters should be allowed in camp other than those for general delivery to messes. The bringing of melons into camp should be prohibited.

The sale of food stuffs and drinkables by keepers of neighboring booths should be rigorously controlled. Only those persons should be permitted to make sales who have been examined for vermin by

a medical officer, vaccinated, received typhoid prophylactic and who keep themselves and their premises clean. Such persons should be re-examined twice monthly and their establishments inspected daily. With a few carefully supervised exceptions they should be permitted to sell only foods and drinks in original packages or cakes, if the latter are protected by insect proof receptacles. The sale of pie should be prohibited. Concessionaires should be required to care for their latrines properly and to make proper disposal of their refuse.

BATHING FACILITIES

If camped along a stream men usually bathe in it, at the point below the place where animals are watered. A shower bath may be extemporized by punching nail holes in the bottom of a five gallon

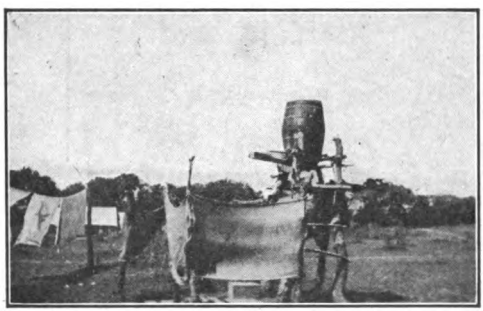

FIG. 60.—Bath tank at El Valle, Mexico.

oil can and raising this to a convenient height by a rope passing over a beam or the limb of a tree. Or a barrel supported on an elevated platform may be used. If the ground water is high it may be pumped from a tube well directly into the barrel. Lacking this, water in containers is carried up a ladder and poured into the barrel to be used as needed. A perforated tin under the faucet will furnish the shower effect. A number of devices for heating water for use in baths were developed in the Punitive Expedition. The simplest of these was to simply heat the water in a galvanized can over the fire in an incinerator. In the 11th Cavalry, water was heated on the top of an adobe stove, which warmed the bath house,

but was stoked from the outside. The water was then carried up a ladder and poured into the barrel from which the shower was drawn.

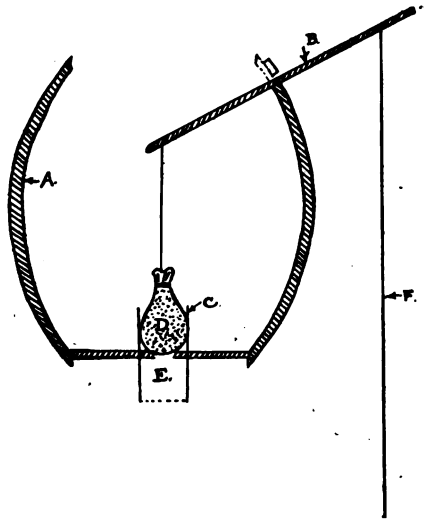

FIG. 61.—Detail of shower bath used in 11th Cavalry. *A*, Wall of barrel; *B*, lever for raising cut-off; *C*, tin can to steady cut-off; *D*, canvas bag filled with sand; *E*, shower head (tin can with perforated bottom); *F*, cord for releasing shower.

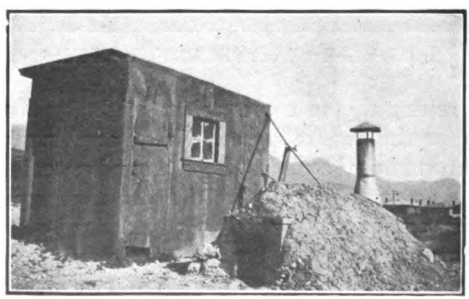

FIG. 62.—Saville bath house.

The outlet was usually closed by a faucet or a bag of sand. Another plan was to heat the water in a pipe which made a coil in an

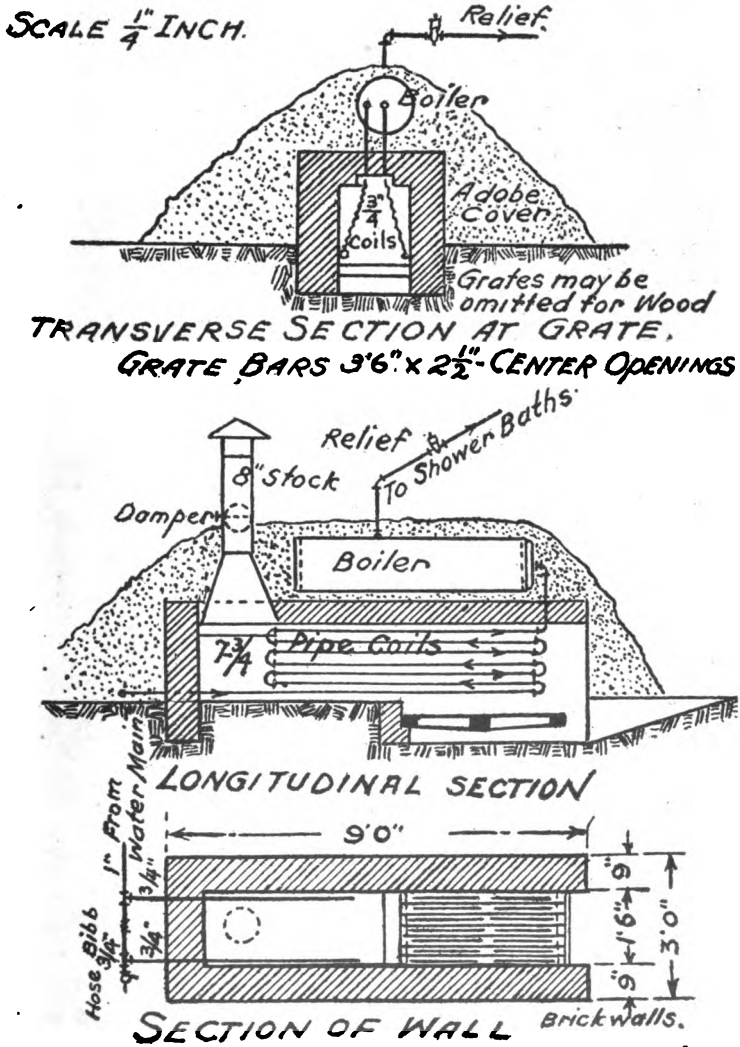

FIG. 63.—Saville water heater. (*Lewis and Miller.*)

incinerator and lead it into an elevated keg in the bath house. At Columbus an improvement was to lead it into a detached boiler in the bath house. The output was diluted with cold water as required in the spray heads. Yet another apparatus devised by

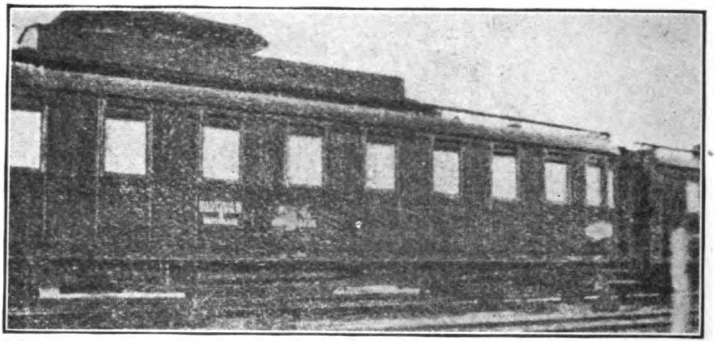

FIG. 64.—Bathing car. (*Austrian service.*)

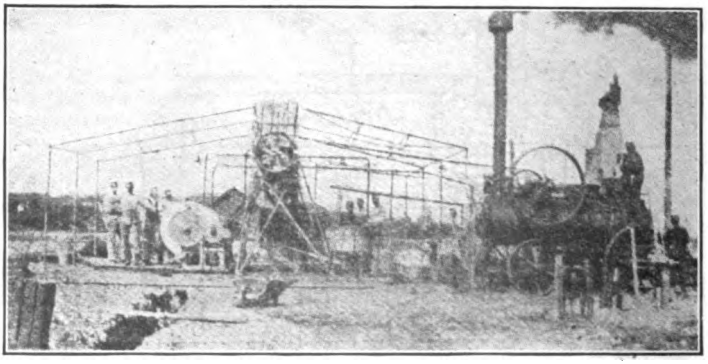

FIG. 65.—Austrian field laundry showing demountable frame for tent (steel); self-propelling engine; mangle (on left); centrifugal drying machine; and tank supported on framework.

Major Saville, Q. M. C. was in use among the troops around El Paso. Its principle and method of operating are indicated by the diagram. "The apparatus cost $35 for each unit or $70 per regiment, and was easily installed. Freezing can be prevented by withdrawing the

water through a cock provided for that purpose, but if through neglect freezing occurs and extends into the water main, great care should be exercised in starting the next fire lest dangerous fires occur." (Lewis and Miller.)

In the trenches water is heated in a small collateral trench which contains a small boiler. This boiler may be covered by a barrel in which clothes are steamed. After use the water is flung on the ground as far as possible from the trench. For the service of some troops in the trenches, bathing trains are run up close to the front. They consist of a railroad train which has been specially devised,

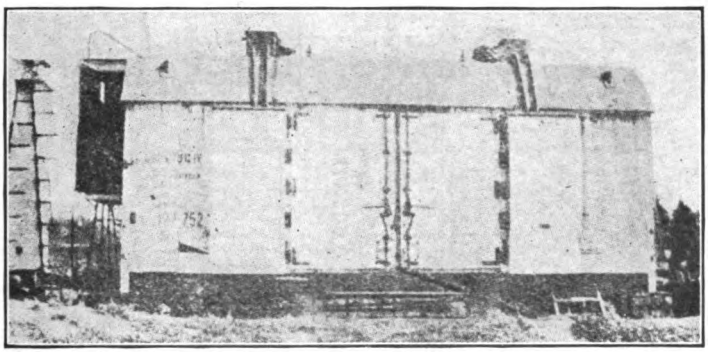

FIG. 66.—Car for disinfecting clothing. (*Austrian service.*) Part of train for bathing.

equipped with shower baths heated from the engine and with cars in which clothing is disinfected. Such a train also carries a supply of clothing which men use until their clothing is returned to them. It accommodates 3000 men a day. Among the Allies, automobiles equipped with apparatus for heating water and with collapsible bath tubs are in use. An appliance said to be used by the Austrian Army for heating water in the trenches is a series of electric stoves which are connected with a dynamo. This is actuated by the motor of the truck which carries this equipment.

The following is the type of fixed bath house adopted by Capt. Goode, R. A. M. C., as described in the Journal R. A. M. C., Sept. 16, 1916. "As regards the building itself, a plan is subjoined. (See

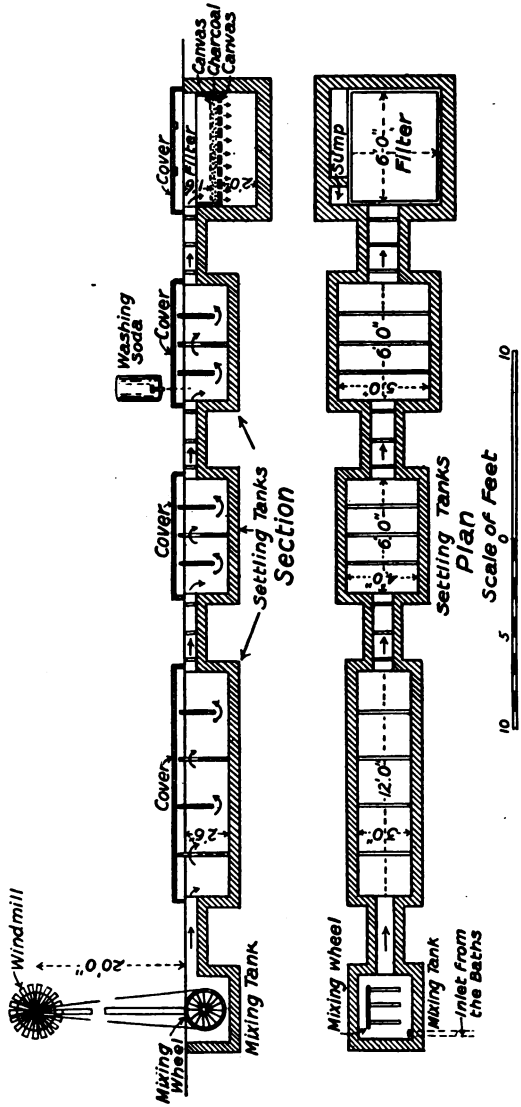

FIG. 67.—Captain Goode's bathing plant.

appended diagrams.) The original canvas structure was replaced by a portable wooden building. It consists of a large undressing room, a bathroom with eight showers, the officers shower bath, a large dressing room, a room for soiled underclothing, a storeroom for the issue of clean clothing, a boiler room, and lastly, an ironing

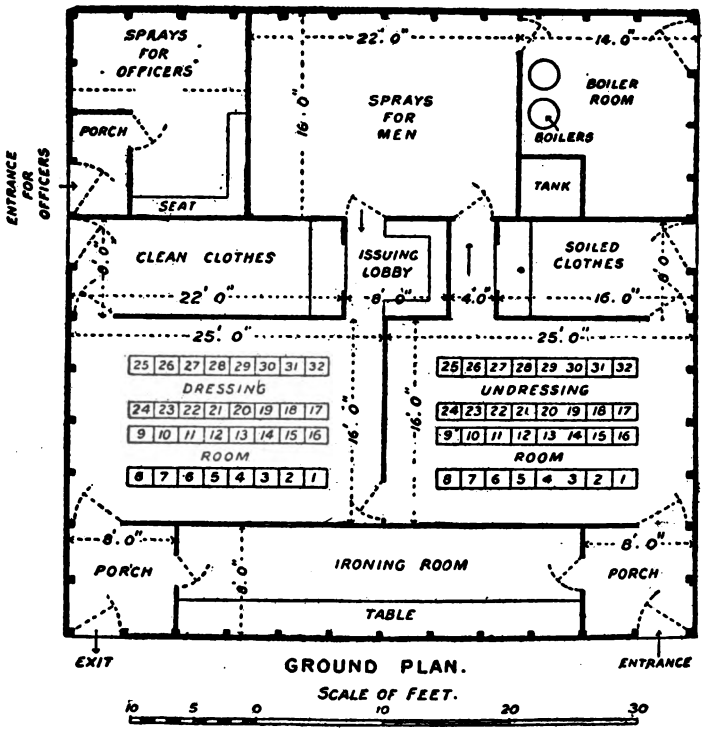

FIG. 68.—Captain Goode's bathing plant.

room for the purpose of destroying the eggs and lice in the khaki clothing.

"The water is pumped by means of a little petrol engine into a 16,000 gallon tank, 24 feet high; thence it runs by gravity to the two connected tanks which feed the boilers, which are independent of each other. The water (hot, cold, mixed hot and cold) feeds the

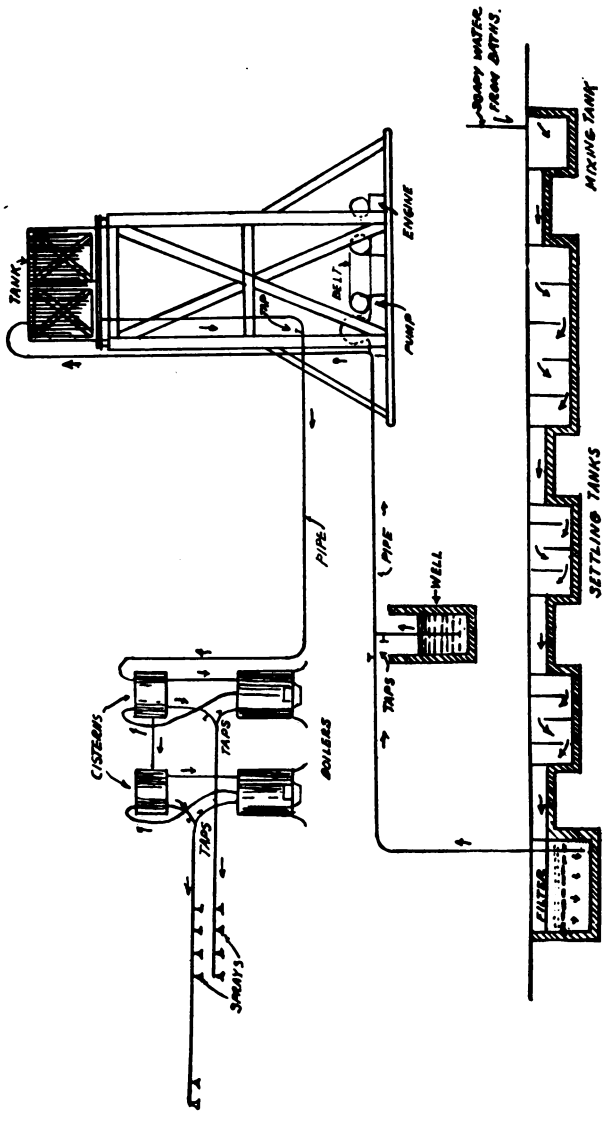

FIG. 69.—Captain Goode's bathing plant, showing water supply.

eight sprays by gravity, sprays being used to economize water, since only 1½ to 2 gallons are required per man instead of six when using tubs. Originally all water had to be carried to the baths by means of a motor tank, holding 120 gallons, from a stream about

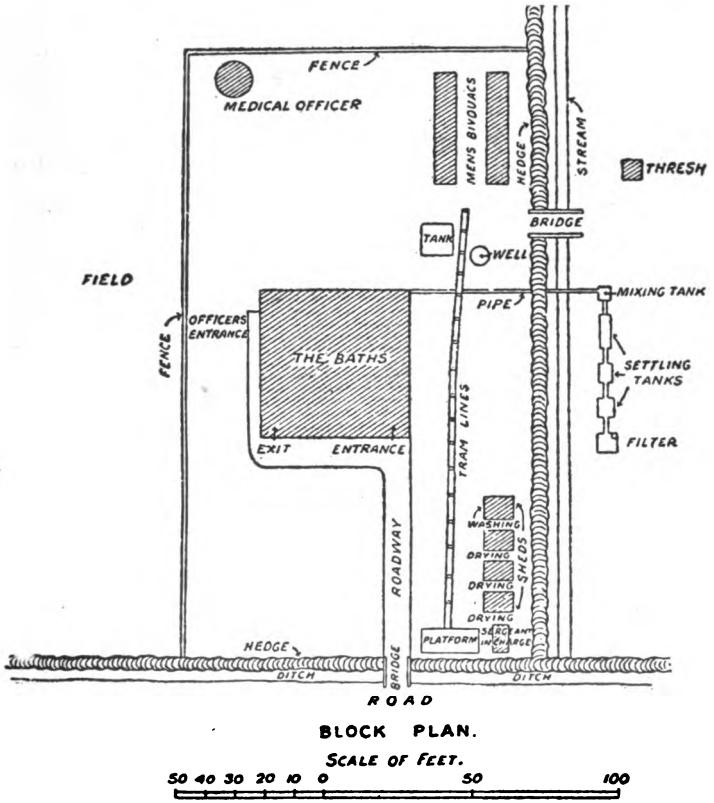

FIG. 70.—Captain Goode's bathing plant.

1½ miles away, as, for convenience of troops, the baths had to be placed in a field some way from the nearest brook. Later three sources of supply were used, the brook mentioned, a shallow well, and rain water from the roof of the plant. This was supplemented

by purifying and re-using the bath water. These three sources are connected up to the motor pump. Thus any one may be used separately to supply the elevated storage tank.

"The method employed for bathing the men is as follows: two thousand men can be bathed per diem. The men are sent to the bath in batches of fifty to seventy-five every half hour, commencing at 8 A. M. and continuing until 12 Noon; then again from 2 P. M. to 6 P. M. The men come to the baths without arms as a rule. Here they undo their puttees and boots and take off their tunics. They then enter the undressing room in batches of thirty-two, and undress. Their breeches are then handed in to the ironing room, where they are ironed in order to kill the lice and nits. The trousers are usually put through the Thresh disinfector. The men, in batches of sixteen, then pass through to the sprays, handing in to the soiled clothes room, their shirts, socks and pants. Three minutes is the usual time allowed under the hot spray, during which time they soap themselves all over, the last half minute being used to wash off all the soap. In the summer the last half minute consists of a cold shower. Thence they go into the dressing room being served on the way out with a clean shirt, a pair of pants and a pair of socks. Meanwhile an attendant has brought around their boots, tunics and other belongings from the undressing room to the dressing room, placing them on the number corresponding with that from which they were taken, the numbers being painted on the tables. When dressed they leave by the exit door and form up outside, another batch of sixteen immediately following through in the same order. The shirts and pants are put through the Thresh disinfector in lots of eighty for from twenty minutes to half an hour at a temperature of 216°F. Twenty minutes suffices if a bottle of formalin has been poured into the Thresh disinfector. The clothes are sorted and the rags burned. The following morning the rest of the clothes are conveyed in wagons to a distributing center where spring water abounds and where labor is obtainable away from the firing line. Here an employee sorts and distributes the clothing to fifty washerwomen who boil, wash, dry, iron and mend them, and then return them tied up in bundles of ten to the distributing center. The same wagons after being washed with cresol solution, return to the baths with loads of clean clothes, each batch of clothes being re-

turned on the third day. Several thousand new shirts, pants, and socks are required monthly to replace wastage.

"Some of the water is used over again. This is of the highest importance for two reasons; firstly, clean water, or even water of any kind, is very scarce. Secondly, it is highly objectionable to pour 2000 to 4000 gallons of soapy water into the ditch near the baths. If this were allowed, it would accumulate and decompose because of the flatness of the country. The following method was devised by Capt. Basil Hughes and Capt. Goode:—The soapy water runs from the bath house into a mixing tank. Slaked lime is placed in this tank, and thoroughly mixed by means of a windmill mixer, constructed from a couple of bicycle wheels and a hoop-pole. When the wind fails, the mixing must be done by hand, which is hard work. The lime throws down the soap as insoluble calcium stearate, bringing down at the same time all the dirt and impurities. The effluent runs through three up-and-down settling tanks, placed all on the same level. These are built of brick with concrete floors. The partitions are removable wooden frames with canvas centers. The three settling tanks are respectively 3, 4 and 5 feet wide. This gradual widening of the tanks tends to retard the flow of the stream thereby assisting precipitation. All the calcium stearates will be found to have settled in the first two tanks. The third tank is used for precipitating the lime and removing the soapy oils. This is effected by means of washing soda, which is run into the tank from a drum containing a saturated solution of sodium carbonate. This precipitates the calcium salts—chiefly hydroxides—as insoluble calcium carbonate, which immediately falls to the bottom of the tank. In addition to this, the sodium carbonate causes the soluble oils from the soap to separate out. These oils, which give the water an odor of soap, float on the surface and are absorbed by means of canvas or sacking nailed to wooden frames. The canvas is changed daily. From this third settling tank the water flows into a charcoal filter, containing four inches of powdered charcoal between two layers of sacking. Through this filter it runs into a bricked, concreted well, and is pumped thence into the elevated tank by the petrol pump. Thin canvas screens, stretched on strong wire frames, are placed in the channels connecting the precipitating tanks. These hold back the scum of lime which separates out on the water

cooling. The first precipitation tank is cleaned out every three or four days, and the mixing tank daily. The sludge is buried. The sludge, which is odorless except for a slight smell of lime, does not show any tendency to decompose. The water after treatment is quite clear, free from dirt, soap, lime and soapy oils; furthermore, it gives a good lather with soap on being used again. The same water may be treated by this method and used an indefinite number of times. The only fresh water required is that to replace the loss caused by cleaning the tanks. No great quantity, however, is requisite, since most of the contents of each tank can be pumped into the succeeding one until the sediment is reached. In experimenting with the working model, in order to ascertain the size of the charcoal filter required for dealing with 4000 gallons a day, it was shown that the rate of flow through the filter varied directly as the height of the super-imposed column of water. A charcoal filter 6 feet square was found to be adequate. This filter consists of a wooden frame 6 feet square and 18 inches high, lined with zinc. The floor, made of zinc, is perforated with holes of medium size. The latter is covered with sacking, on which a layer of powdered charcoal 4 inches thick is spread; this is covered with sacking which is changed and washed daily. A separate bathroom for officers, on the same principle, has been added, accommodating thirty-five in one day. The system is characterized by its easy method of construction, its simplicity and mobility. It has been working for several months, and its results have proved satisfactory in every way. Capt. Goode strongly recommends it as highly suitable where large numbers of men have to be dealt with and more especially in those places where water is scarce."

When the retention of water is not desired as in the plant described by Capt. Goode, its disposal may be a matter of some difficulty. A supply of five gallons per man per day for all uses about the camp is adequate and the employment of a larger amount should be discouraged unless sewer facilities are provided. Most sullage water may be disposed of on or in the soil. In the El Paso District ablution water was scattered widely in the sun. Water from bath houses was led into pits 15 feet in diameter and 20 feet deep. If the pit reached a sandy layer it usually drained well, but if fluid did not disappear it was removed by an odorless excava-

tor and disposed of two miles from camp. When the sides and bottoms of the pit became covered with soap and grease, the infiltrated soil was removed to a depth of six inches.

In order that sullage water may be absorbed it is essential that it be freed as far as possible of finely emulsified fat which clings to absorbent surfaces, occludes them and becomes offensive.

The only generally available material for filtration of finely divided fat from sullage is sand. The following device for its removal is similar to that for removal of fat from waste water at kitchens. A box or a pit lined by puddled clay, should have a few inches of sand placed in it. It is divided by a transverse vertical

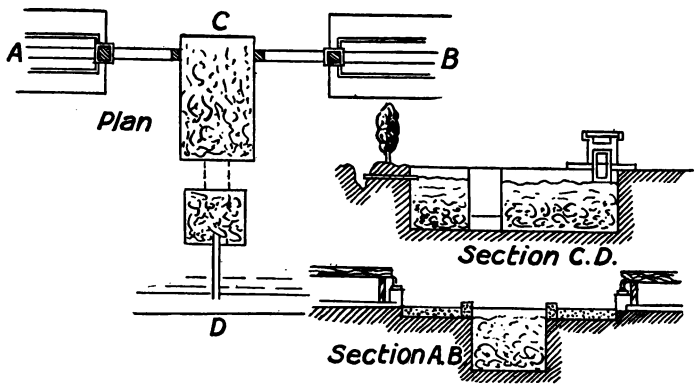

FIG. 71.—Ablution trenches, and disposal of waste water. (*Pike.*)

partition. The lower edge of this partition should be two inches below the surface of the sand but an inch or two above the bottom of the pit. Sullage is discharged into one compartment, passes through the sand and underneath the partition, so that a clean effluent flows away from the top of the distal compartment in the box. A plug of absorbent material floating in the proximal compartment will entangle the floating fats and the mass can be removed and burned. The sand gradually becomes clogged and the surface layers must be renewed. This may be effected conveniently either by having a bung in the side of a box so that the water can be run out, or by having the sand placed in a removable tin per-

forated at the base. Pike describes another device, as follows: "The water passes from the ablution bench through a biscuit tin containing hay, into a pit filled with broken brick. From the bottom it rises through a second pit also filled with broken brick, whence it flows through surface drains filled with rubble or cinder, either direct into a ditch or into a patch of ground prepared by digging over the surface one foot deep. A second patch of ground is prepared for use when the first becomes water logged, the two being worked alternately (Fig. 71).

A more elaborate soap trap and one which gives excellent results is illustrated in the sketch. It is suitable for standing camps.

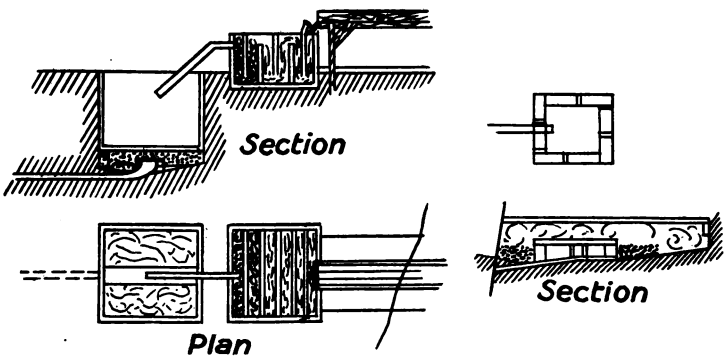

FIG. 72.—Soap or grease trap. (*Pike.*)

It consists of a stout wooden box, four feet square and two feet, four inches deep, which is divided vertically into six compartments, four filled with straw and two with coke, thus providing alternate downward and upward filtration. From the box the effluent discharges from a pipe into a boarded pit 5 feet square and 4 feet, 9 inches deep, containing three inches of coke covered with 9 inches of sand. The floor of the pit slopes to a small central chamber 13½ inches square, formed of one layer of loose bricks covered with sand and wood or tin. The water from the box falls onto a board resting on the filter and is thus distributed over the surface without disturbing the sand. After passing through the filter it drains into the catch pit, whence it flows through a discharge pipe into the ditch or pond.

The following sketch illustrates a modification of the above design suitable for use in the field. Its practical advantages are that it can be dug in the ground; it requires a fall of only 2 feet 6 inches and it obviates the necessity for the somewhat cumbersome box.

The dirty water passes through a tin containing hay, into a trench 6 inches deep and three feet long, through a second tin of hay, the sides of which are perforated back and front, and into a pit 3 feet square and 4 feet deep. A wooden partition wall reaching from the surface to within 6 inches of the bottom divides the pit into two

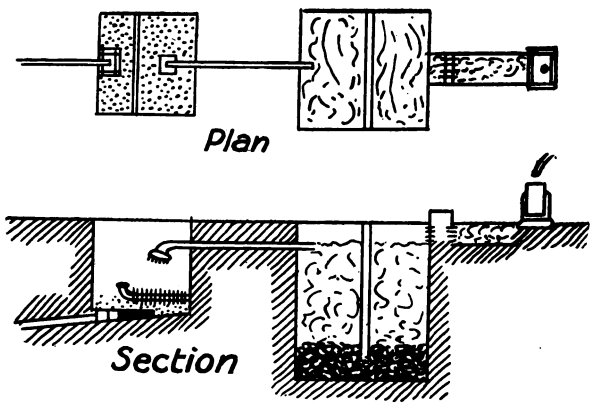

FIG. 73.—Soap or grease trap. (*Pike.*)

compartments connected at the base. The water passes down through 2 feet 3 inches of broken brick and one foot 3 inches of coarse rubble in the first, and up through one foot 3 inches of coarse rubble and 2 feet 3 inches of fine ashes in the second. It then passes into another pit through a pipe with a rose spray. This second pit is 2 feet 6 inches deep with a slight fall to the outlet pipe leading to the pond or ditch. The effluent falls in a spray on to a tray of perforated tin resting on a final filter bed, composed of 6 inches of sand over 3 inches of broken brick—the outlet pipe being protected by a small catch pit made of loose bricks covered with tin.

Having removed the fats disposal of the effluent is usually not difficult. In geological formations where clay exists it may be in "pockets" with intervening porous material, and the porous interspaces can be found by trial pits. If there be a continuous clay layer, sullage cannot be absorbed and the site is so damp and cold that it is not suitable for camping purposes. If this effluent is cleared of soap and oil and the soil absorbent, the sullage may be disposed of either by soakage pits or broad irrigation. The former are similar to those just described for the El Paso District. They may be smaller—one for each company. The method of disposal by broad irrigation is applicable to sloping surfaces which may either allow the liquid to soak into the soil or drain down the surface into a ditch. If the liquid be allowed to soak into the soil parallel ditches should be dug along the contours and the fluid allowed to fill them successively. The ground should be divided into areas which should be used for a day and then allowed to dry for a day or more, when the soil lining the ditches should be turned and loosened preparatory to being used again.

When water is piped into camp ablution water is drawn from a faucet. The practice of providing a rock filled soakage pit near a faucet is disapproved by Lewis and Miller as organic refuse is often thrown on it, and flies soon begin to breed in the moist, polluted soil on the sides of the pit. They advise that the drip be arrested by one large flat stone and led away into the open ditch, after passing through soakage pits, as indicated in the diagram.

Each division should be provided with two baths each capable of caring for 80 bathers an hour, and two trucks carrying disinfecting apparatus.

Laundry.—Laundries employing Hospital Ward tents may be erected as near the front as possible. They should have concrete floors, with shallow drainage runnels, which lead into a series of settling tanks filled three-fourths with coke. The water flows from one tank to the other over or under an incomplete partition. The tanks should be examined daily and the effluent led into a soakage pit. Excess can be carried off by a ditch.

Latrines.—Field Service Regulations require that latrines be placed at the opposite end of the company street from the company kitchens. Usually one is provided for each company, and one for

the officers of each battalion. They should be dug if troops halt only for a few hours. In sites subject to inundation, they should be ditched and the edges banked. If dug in sandy soil they may have to be provided with retaining walls of timber as in the camp at Galveston in 1911 or revetted with sand-bags. In rocky soil they may have to be blasted as in the El Paso District, where each latrine pit cost $30.

Latrines for very temporary use are about 4 feet long, 1 foot wide and 1 foot deep for each day's use, though provision of 2 feet would be better. The men using these trenches straddle them so that both urine and feces are discharged into the pit. This method of use is much better than that of squatting on the edge of the pit, which results in the ground under foot soon becoming soiled and muddy with urine which is tracked into camp. These pits in many respects are much more desirable than the large ones, unless these be protected by boxes, provided for fixed and semi-fixed camps. Each man using an open trench should cover his deposit with earth thrown into the pit from a tin can and not kicked in carelessly with the foot.

A short, uncovered straddle trench accommodates one person at a time. They should provide for 33 per cent. of the unit for one day's stay or 20 per cent. for a longer camp. The frontage in feet is one-fifth of the total strength. The width of the latrine area of a company is 4 feet for each two days' stay. These pits should be filled in when filled to within one foot of the surface, covered with puddled clay and marked.

An improvement on the short, open straddle trench is provided by the Lucas top which will permit three men to use the trench at once, and which renders it fly proof. This top may be made of wood or sheet iron.

The straddle trench is undoubtedly superior to the long deep pit for temporary camps, but has never been popular in the American service. The pit usually employed for permanent or semi-permanent camps is 3 feet wide at the top and 2 feet at bottom and 8, or better, 10 feet deep. Its length depends on the size of the command it is to serve. From 5 to 8 per cent. of the command should be accommodated at one time, and 2 feet of linear space allowed to each man. As usually constructed in the field, where box seats are

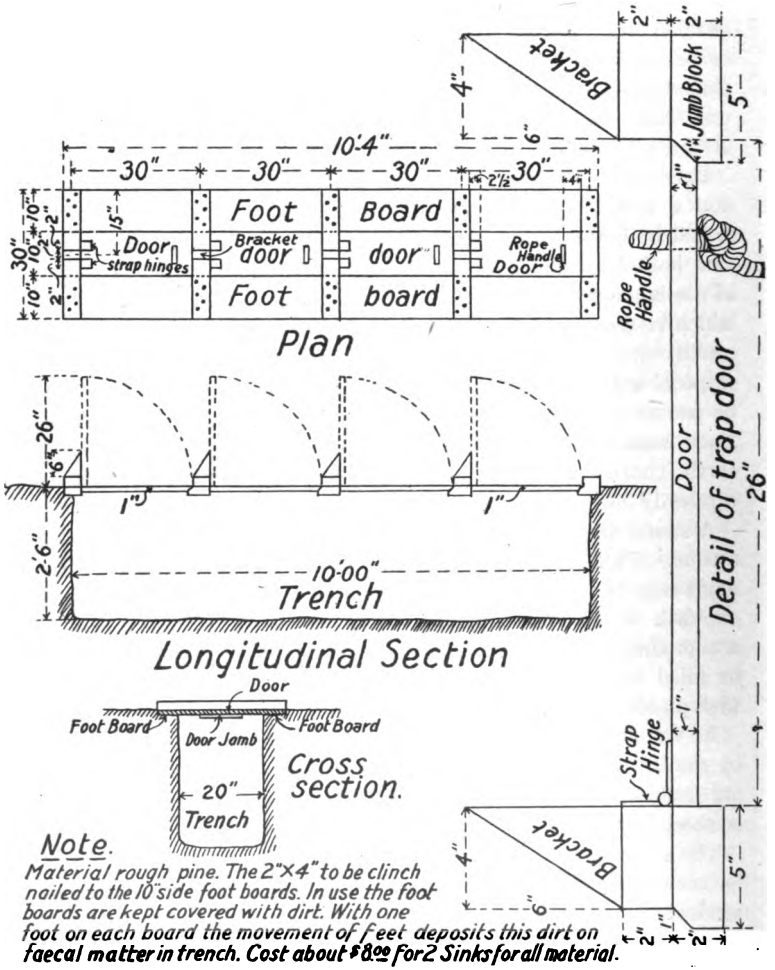

FIG. 74.—Lucas' straddle trench cover.

not obtainable, the pit is slightly (1 foot) wider at top than at bottom and is provided with a seat. This is a long pole or sapling resting on forked sticks or curved logs about 3 feet beyond the ends of the pit. Each man is required to cover his deposit with earth.

The latrine is surrounded with brush, or a canvas or burlap screen, and covered with a tent fly or other suitable material.

The Havard box is thus described by its inventor. "The latrine box is 10 feet 6 inches long, 16 inches high and 3 feet 8 inches wide

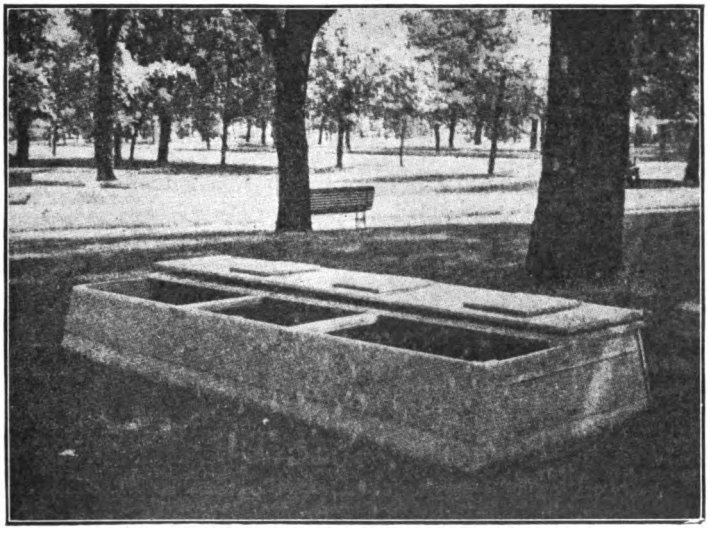

FIG. 75.—Movable latrine box, with one-half of the top shifted over the other half for inspection and disinfection. (*Havard.*)

at bottom so as to safely cover a pit 3 feet wide. The sides or walls have an inward slant of 4 inches and are locked together by the end pieces and two traverses. The top consists of two longitudinal halves, simply laid on and kept from slipping by blocks; each 21 inches wide, projecting 2 inches beyond the side, and perforated by three holes which alternate with those of the other half. Each hole, 11 inches long, is covered with a strong hinged lid which can only be raised to an angle of 45 degrees, so that it is self closing and prevents standing on the edge of the box.

Each box consists of eight pieces perfectly interchangeable with those of any other box, and weighs 175 pounds. It can be put together without screw, bolt or hook, or taken apart, by one or two men in a few minutes. To disinfect the pit, the attendants lift

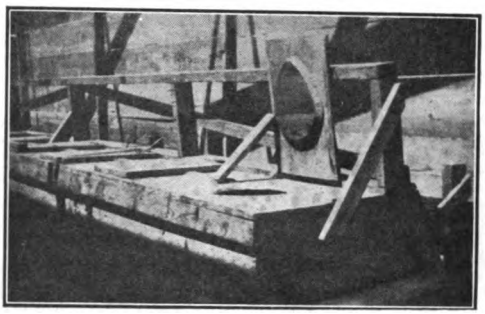

FIG. 76.—Latrine box, usual type. Seat cover raised. (See diagram at end of book for dimensions.)

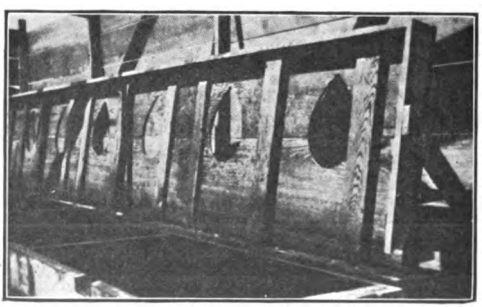

FIG. 77.—Latrine box. lid raised for treatment by oil and lamp black. This mixture is strained immediately before use through a sieve made of two layers of wire mosquito net tacked to a square wooden frame 8 inches square and 1 inch deep.

the half of the top nearest to the earth pile and shift it over the other half, thus uncovering the pit and obtaining a good view of the contents. One pit 10 feet long covered with this box will do a company for a week; if the stay is to be longer, the pit should be of the standard length of 20 feet and two boxes used, end to end.

For urinals, tubs, cans or boxes must be provided, one at each end, with a pipe, gutter or trench leading into the pit."

An important addition are strips of tin nailed under the front of each hole to deflect urine into the pit.

The boxes at present provided in most permanent camps are not demountable and have the seats facing in one direction. When

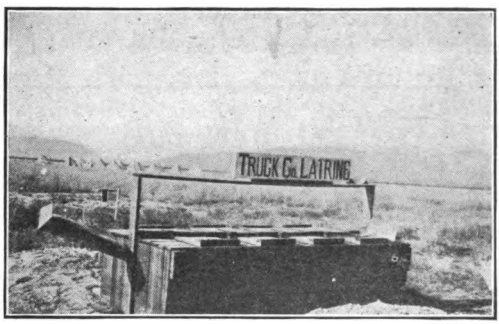

FIG. 78.—Extemporized latrine box.

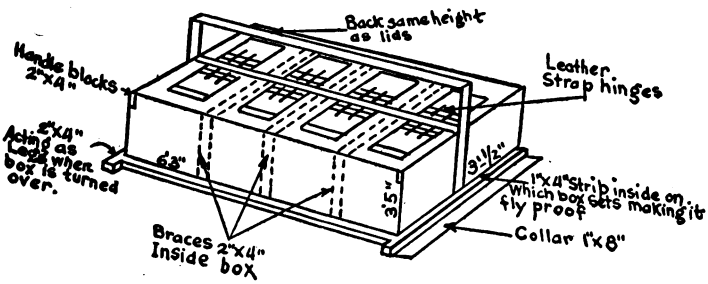
Back same height as lids
Handle blocks 2"x4"
Leather Strap hinges
2"x4" Acting as Legs when box is turned over.
62"
9½"
1"x4" Strip inside on which box sets making it fly proof
Collar 1"x8"
Braces 2"x4" Inside box

FIG. 79.—Hopwood latrine box used in camps at Columbus. (*After Lewis and Miller.*)

this type is used, the cover should be hinged, to give easy access to the pit, for the boxes are heavy and unwieldy.

A better box than the elongated one is Hopwood's, which is similar to Havard's except that it is not demountable, and has the seats back to back. It is greatly superior to the elongated box as it requires less lumber and is more wieldy.

Hopwood recommends a galvanized iron can as a urinal, which is emptied into the pit each morning.

Whether Havard's or Hopwood's box is used these should be provided with a sill or collar, 8 inches wide, to prevent crumbling of the edge of the pit. The box rests on this sill but is not attached to it.

These boxes may be extemporized from shoe or clothing boxes, etc., but these makeshifts are fragile and warp readily. In such cases warped lids should be padded and fringed with burlap, and cracks or knot holes occluded by the same material. The inlets for urine,

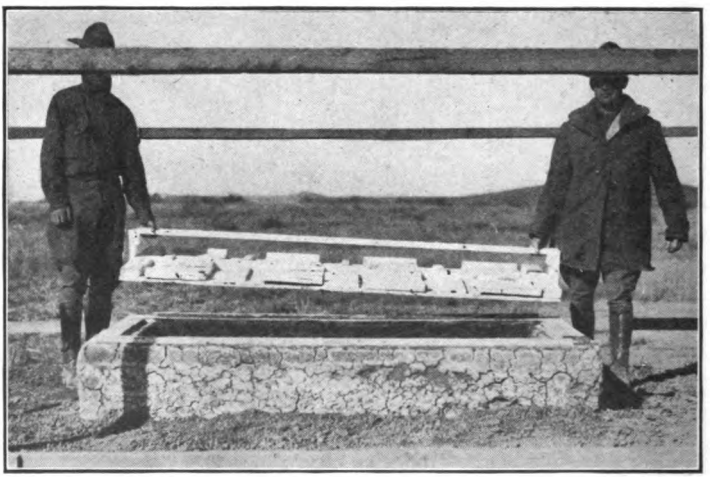

FIG. 80.—Garcia's latrine cover.

if troughs are used, should be fly proof. A fly trap should be kept habitually over a disused seat if the pit is found to harbor flies. This trap should fit snugly to the seat. If a pit becomes heavily infested it should be filled with water to a depth of four inches above deposits in order to drown larvæ. A barrel of fresh lime is then slaked in the pit. The heat thus developed destroys larvæ which may have escaped destruction by the water alone. Truby, who devised these measures advises, that if latrines be but lightly infested they be burned out twice daily with oil.

Garcia recommends that when lumber is scarce, the wooden sides

of the box be replaced by an adobe wall 2 feet high surrounding the pit. Special bricks measuring 6 × 18 inches are required to avoid making the wall too wide. A frame made of 1 × 6-inch lumber is set into the top of the wall. The cover fits into this frame. It is easily handled by two men. Other advantages are the small amount of lumber required, the chimney effect of the walls and the greater portability of the top and frame than that of the latrine box.

Latrines should be inspected by a medical officer at 9 A. M. and at 4 P. M. daily. They should be inspected each two hours by an enlisted man detailed to that duty. A permanent detail should care for them. Seats should be scrubbed and urine troughs or cans should be swabbed out burnt out respectively with crude oil. All trenches should be filled in before a command moves.

The practice of burning out latrine pits inaugurated by Col. Ebert has proven generally satisfactory when carefully performed. For this purpose 1 gallon of oil and 15 pounds of straw daily are provided for each company latrine. The box should be removed during combustion and the fecal matter stirred into the fire with a pole. This incineration if thoroughly carried out with dry fuel is practically successful in making latrines fly proof. When oil and straw are not obtainable as was often the case in the Punitive Expedition, the ashes from the company kitchen should be scattered in the pits.

In the El Paso District the practice of burning out was discontinued and a mixture of lamp black or bone black in crude oil, 1 pound to 3 gallons, was employed. From ½ to 1½ gallons of this was applied by a spray pump daily and once each week or ten days the sides of the latrine were sprinkled. It is essential that the lamp or bone black be as fine as flour otherwise it will not pass through the apertures of the spray. The mixture must be stirred constantly while being pumped and sprayed, or mixed and heated and passed through a fine mesh sieve. By this method, a squad of one N. C. O. and 4 Mexicans can treat 75 latrines in 5 hours using 55 gallons of oil for this purpose. The equipment at El Paso consisted of a wagon and drum containing oil, a force pump and spray. The pump was used to spray walls only as the outlet was small and choked quickly in cold weather. At Camp Funston, for 3000 men, the spraying was done by two Mexicans, using a small hand pump

and two buckets. The mixture may be poured from a sprinkling can. Crude oil alone for this purpose has been suggested but its value is much less than that of oil and lamp black. For proper use of this method, tops of latrine boxes should be hinged so as to allow free access to their interiors and to the pits.

When pits are filled to within two feet of the top they should be filled in, rounded up, marked, and covered with 4 inches of puddled clay.

FIG. 81.—Hand-and-foot spray pump for use in applying bone black and crude oil mixture in latrines. Bone or lamp black may be of any quality provided it is fine as flour. The mixture is strained before use by passing through a sieve made of several layers of metal mosquito netting. Several spray tips should be on hand in reserve.

The necessity for properly disposing of urine is not generally appreciated because of its comparative inoffensiveness in small quantities. One thousand men, however, void daily 300 gallons. In this number of men there are certain to be some who are typhoid carriers whose urine may contain 100 million bacteria to the cubic centimeter. Evaporation is impracticable for small units though a number of devices have been employed for that purpose. Urine cans are not always available and the congestion at the latrine after reveille is such that additional facilities should be provided. The English service employs two trenches, 6 inches deep and 8 feet long at an angle of 30 degrees, leading into a soakage pit. The disadvantage of this practice is that one side soon becomes fouled and that urine is tracked into camp. Lelean recommends that each regiment be supplied with two dozen nested funnels 4 feet long, 6 inches in di-

ameter at one end and 2 inches at the other. In their absence tubes made of tin cans can be employed. A pit is dug and filled to near the top with broken stone, or tin cans in which many holes have been punched may be used. The funnels or the improvised tubes are inserted at a convenient height. The pit is then filled up, covered with sod and roped off. The funnels are lightly plugged daily with grass to make them fly proof.

A sewer system is the cheapest method of disposing of excrement in a permanent camp. This however requires a relatively large water supply which is not always obtainable. In the camp at Galveston, where a sewer was available, a limited amount of water proved adequate by using the following method. Two galvanized iron troughs, 20 feet long, and 18 inches deep were provided for each battalion. They sloped downward slightly to a common center, where a vertical chute, ordinarily closed by a padlocked plunger, descended into a manhole of the sewer. The lower end of the plunger which entered the chute was 6 inches in diameter. A cross piece through the handle prevented the plunger descending more than 2 inches into the chute. Below this point was a net made of ¼-inch G. I. wire with ½-inch interstices, to act as a strainer. The troughs were filled twice daily with water to within 4 inches of the brim at the lowest point. They were emptied twice daily and flushed with a hose, fastened to the faucet from which each pair of troughs was filled. The net provided at the outlet was essential, as the sewer was emptied by a centrifugal pump and despite standing orders, obstructing matter such as old clothing, orange or banana peeling, etc., was occasionally thrown into the troughs.

A better apparatus devised for a similar purpose by Major Willard F. Truby for occluding the outlet of a latrine trough consists of a wooden screw, 6 inches in diameter, one-fourth of whose side is cut away. This allows a space down which the overflow may pass, yet arrests large obstructions. The best device for the outlet from these troughs is similar to that provided for the modern bath tub. A screen over the outlet arrests obstructions to the pipes, an overflow hole is provided at a convenient height, and a plunger, outside the tub, controls the outlet pipe.

Pollution of the camp area by urination or defecation should be punished promptly and rigorously.

Whitewashed urine cans or tubs should be placed in company streets at night, removed at reveille, emptied into latrines, burned out with oil and sunned during the day.

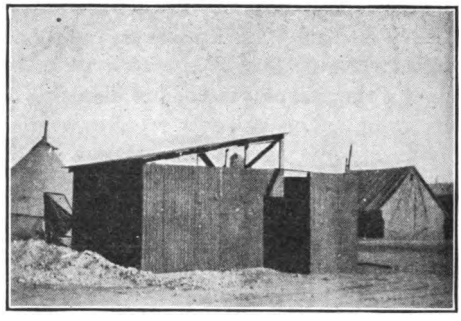

FIG. 82.—Galvanized iron latrine shelter.

In fixed camps latrine shelters consisting of a galvanized iron shed may be provided, as that devised by Hopwood. If pits are properly cared for it is not necessary that such shelters should be screened. At Dublan, Mexico, when no other material for

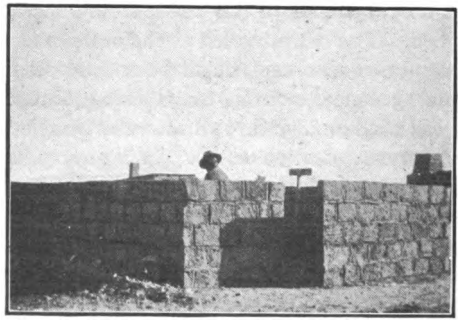

FIG. 83.—Latrine shelter made of adobe bricks.

privacy was obtainable, the latrine areas of the 24th Infantry were surrounded by adobe walls, 4½ feet high.

In some localities because of tactical considerations or the geolog-

ical formation none of the methods described above for the disposal of excrement is applicable. In the trenches excrement is disposed of in several ways. The simplest plan was for men to

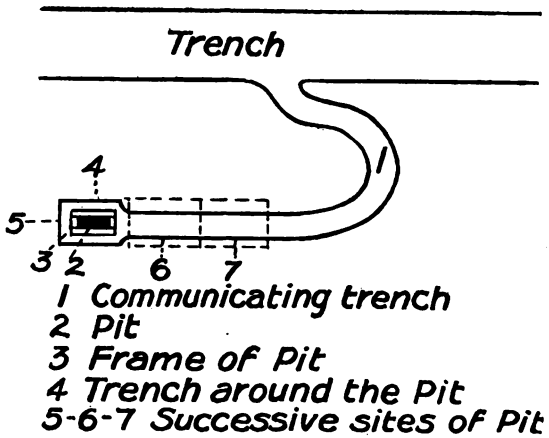

FIG. 84.—(*After Tournade.*)

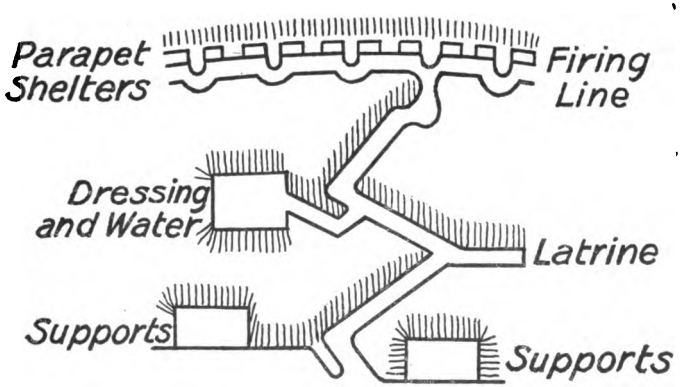

FIG. 85.—Communicating trench from supports to firing line. Corners rounded to permit loaded litters to pass. Not drawn to scale. (*Eltinge.*)

leave the trenches at night and defecate at any convenient point in their rear. This drew flies, and excrement was soon tracked into the trenches and dug-outs. Then latrines were dug at convenient

places and used at night. These latrines, 2 feet long, a spade width wide and as deep as possible, were dug in small trenches, off shoots from the main one or from the communicating trench, or behind contours that afforded protection from enemy fire. Eventually on the western front, the pail system was adopted. Excrement was received in buckets placed in bomb-proof cellars. These were removed by the troops when relieved who cleaned them, buried the contents and brought them back when they re-entered the trenches.

A battalion of 1000 men excretes 600 pounds of filth daily, of which 500 pounds is liquid. This excrement is received in 10 buckets. The fluid in one bucket can be absorbed by 10 pounds of sawdust or other material of equivalent absorbent and fuel value. Fluid can

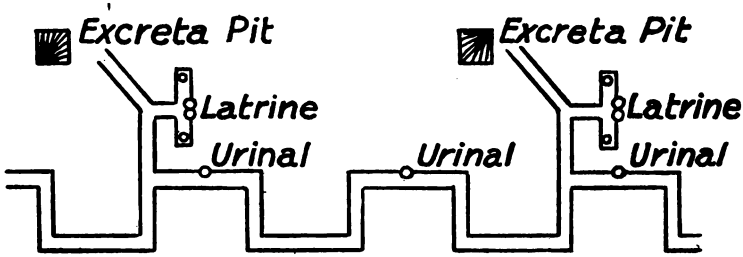

FIG. 86.—Trench latrine. Diagrammatic. Not drawn to scale. (*Pike.*)

be evaporated under field conditions when mixed with 66 per cent. of its weight, of combustible material (matrix) such as sawdust or dry stable litter, which is then burned. Under more favorable conditions, this ratio of efficiency is doubled.

The total fuel required to completely incinerate the 500 pounds of liquid excreted by a battalion daily is, on the foregoing basis, 330 lbs. As the total combustible refuse from such a unit averages about 1500 pounds a day, it should be self supporting or at most require less than 100 lbs. of sawdust daily, if the refuse used is not adequately absorbent. Dried manure may be employed. Each horse passes about 8 pounds a day—enough to incinerate the excrement of 4 men (Lelean).

The following are certain types of disposal by the pail system employed in the British service in the trenches. Small communication trenches are made leading from the main firing and support

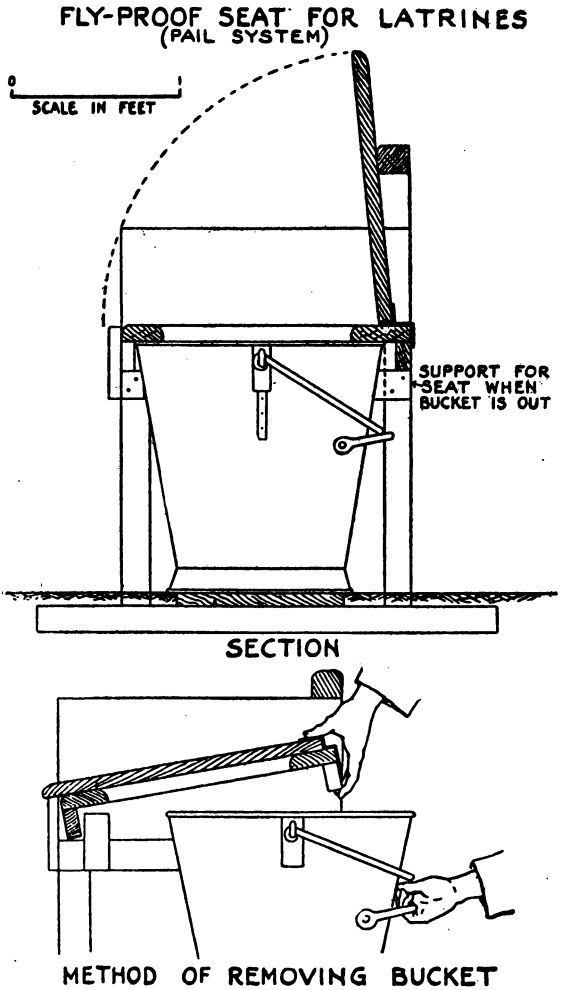

FIG. 87.—Fly-proof seat for latrine, pail system. This system may be used for one or a number of flat-topped buckets. The cover is removable. It packs flat with the rest of the frame during transport, and in use is supported by the top of the bucket. (*After Lelean.*)

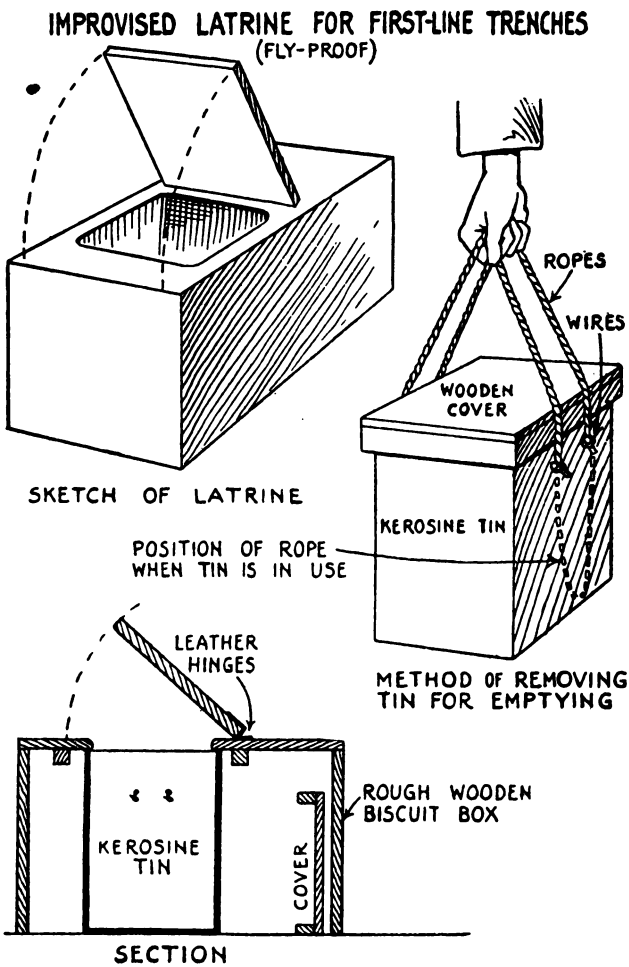

FIG. 88.—Improvised latrine for first line trenches. (*After Lelean.*)

trenches. These are fitted up with latrine buckets or urinals, and urine cans may be suspended from the walls.

Containers are of various materials, *e.g.*, a stout galvanized iron bucket shaped like a coal scuttle with a swinging handle on the top and a fixed handle half way up the front or back, cresol and paraffin

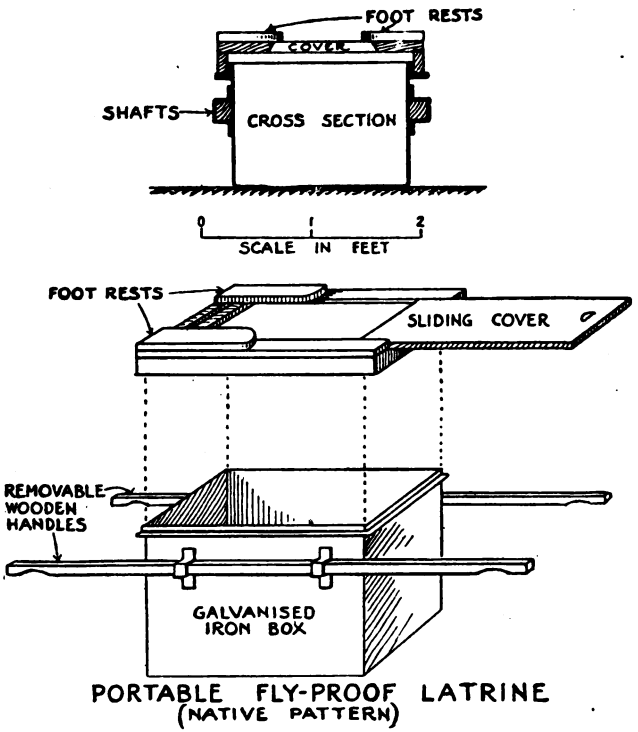

FIG. 89.—Of service for use in the trenches. The lid may be made of tin—wood, swells when wet and jams when dirty. Entire cover removable. (*After Lelean.*)

drums, chloride of lime cans, hard bread tins, etc., fitted with wire handles. A combined latrine was made of two chloride of lime tins. Men were instructed to squat over these tins in such a way that urine was caught in one tin and feces in the other. To insure their occupy-

ing the right site, bricks or blocks of wood were placed to indicate the position of the feet. The advantage of keeping the solid and liquid excrement separate is that much less earth is necessary to cover the former and the container fills less slowly. A better plan is to suspend a trough and a row of buckets beneath a pole or seat. The former catches the urine and conveys it to a soakage pit. The latter are removed as required.

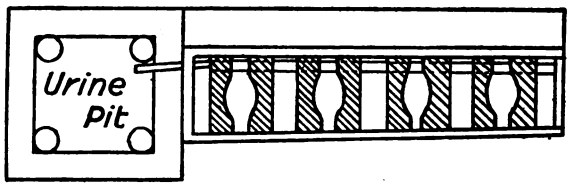

FIG. 90.—Latrine separating urine and feces. (*Pike.*) Urine is caught in a trough which leads to the urine pit. Feces are caught in pails and removed daily.

Yet another plan is to perforate latrine tins with holes, a few inches above the bottom and sink them in a trench filled with broken bricks. The urine drains into a pit and the solids are buried or burned.

MacPherson's system uses a large rectangular can cut in half. These halves are supported at their overlapping ends on a trestle. Urine is caught in the front tin and feces in the back. Before using this apparatus a man takes a piece of newspaper cut to convenient size and places it in the back tin. After defecation, he takes the two halves apart, empties the urine into a tub and the feces into an incinerator. The process is simpler than it sounds.

To disinfect feces tubs, chloride of lime is used from time to time, or a sprinkling of cresol. The latter is also used in urine tubs. Latrine buckets should be cleaned daily. They should be mopped out as soon as emptied with 3 per cent. cresol and smeared with vaseline. Sandbags are hung at the doors of dug-outs, for reception of rubbish which is collected and burned daily.

The excrement is usually buried in pits about 10 feet square and 4½ feet deep, with fly proof covers. These covers are removed daily and the pits burned with hay and oil. Or, in uncovered pits, a foot of earth is thrown on each day's deposits.

For the disposal of excrement and refuse, various types of incinerators are now used in the English service. Two main types are

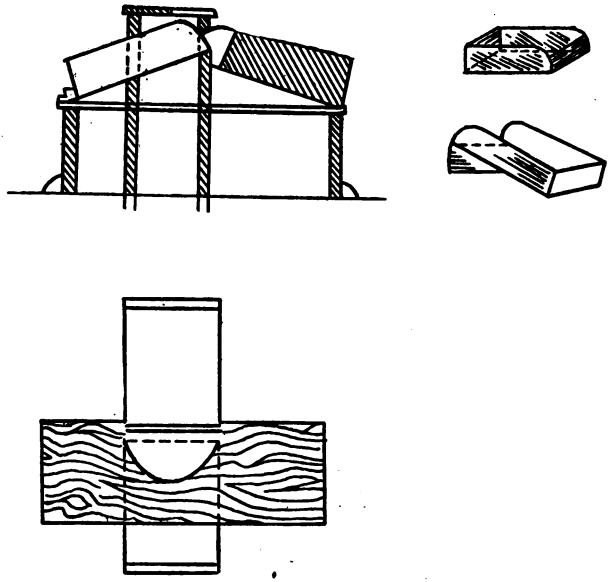

FIG. 91.—MacPherson's latrine for separating urine and feces. (*Pike.*)

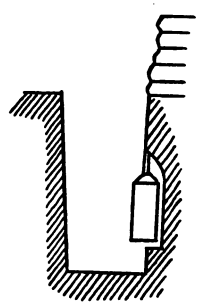

FIG. 92.—Trench urinal. (*Pike.*)

recognized—the open and the closed. The former consists merely of a grate and its supports. Objections to incinerators of this type

are that they are slowly erected and started, use a large amount of fuel, give rise to offensive odors, are easily rendered ineffective by rain, and their contents are blown away by winds.

Of the closed types several patterns are described.

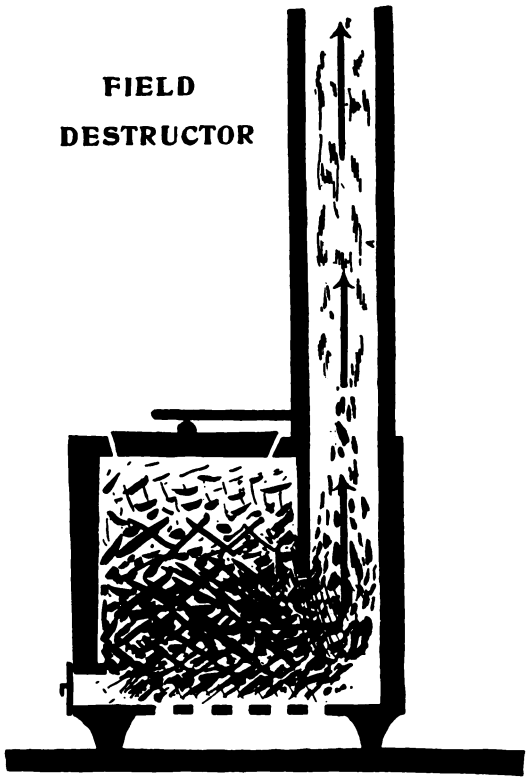

FIG. 93.—Incinerator. (*After Lelean.*)

1. The roofs and walls consist of sheets of corrugated iron. The walls are perforated near the bottom and receive the bars of a grate which cross the bottom of the chamber.

2. The roof and walls consist of sheet iron, hinged to a grate over which they can be made to fold up for packing. Extensions of the

rods which attach the plates to the grate act as legs. A chimney is hinged to the roof. This apparatus weighs 50 lbs. and has a capacity of 8 cubic feet.

3. Another type having a capacity of 16 cubic feet is illustrated in the accompanying diagram of a field destructor. The essential part

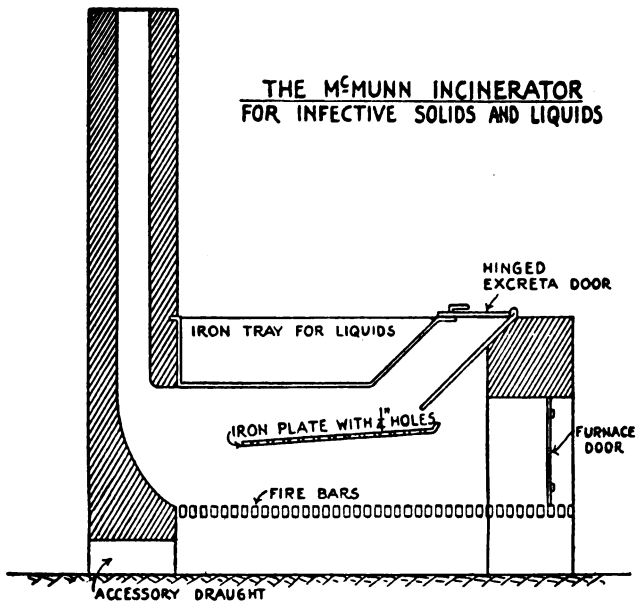

FIG. 94.—Tray receives urine. Sawdust is added. It increases evaporation 30 per cent. When thoroughly hot, wet sawdust is raked into incinerator while feces mixed with sawdust are thrown in on the drying plate. More are added as required. One such plant disposed of the following in 24 hours: 130 gallons of liquid, excreta, of 200 patients, 180 lb. of wood, 50 lb. of sawdust and hospital refuse. Requires one man's steady attention. (*After Lelean.*)

is the baffle plate which separates the fire box from the chimney. The material introduced is burned and escapes as ashes and thoroughly oxidized gases, which renders this device void of offense. The minimum effective flue temperature is 500 degrees F. A drawback to the use of this device is its weight, 3200 lbs. (Fig. 93).

No excrement should be thrown on the fire until this is white hot. About 30 pounds of excrement are thoroughly mixed with 30 pounds of absorbent fuel. This quantity of material is thrown on the

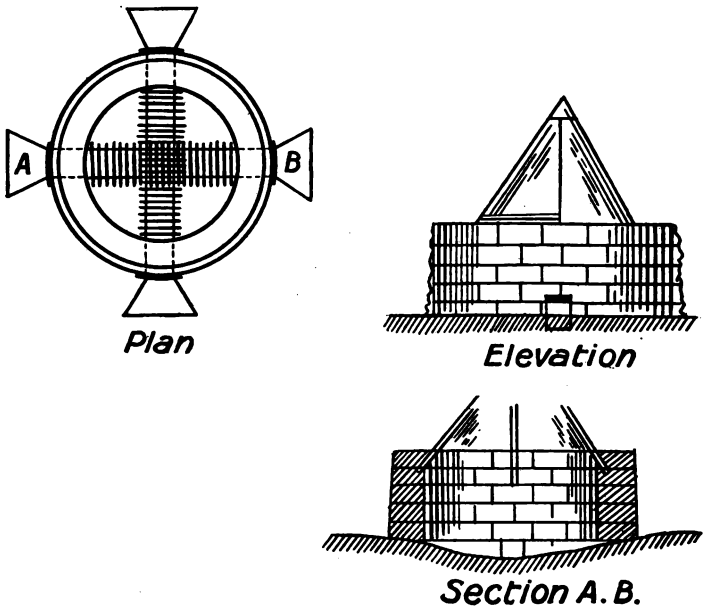

FIG. 95.—Incinerator. (*Pike.*)

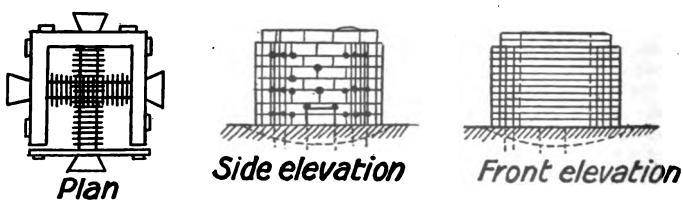

FIG. 96.—Turf incinerator with corrugated iron front. (*Pike.*)

fire every half hour with other fuel as needed. This apparatus will dispose of the dejecta of 1000 men daily. The fire should be damped at night and stoked in the morning. For the transportation of the buckets low trucks are provided to prevent spilling. They are

equipped with hoops and swivel hooks from which the buckets are suspended by the handles.

A more elaborate incinerator is such as that figured in the diagram 94.

Such apparatus shown should contain two grates, on the first of which material is dried and on the second incinerated.

For extemporized incinerators the best material is brick, but in its absence puddled clay is used. A convenient method is to use sand-

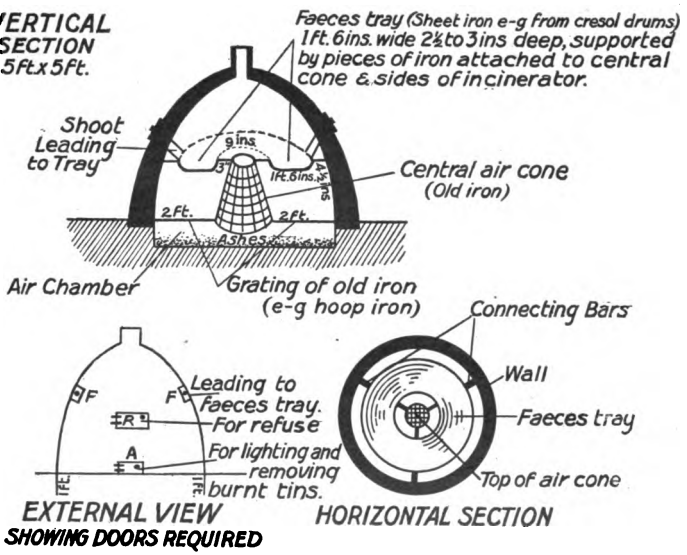

FIG. 97.—Turf incinerator. (*After Trinca.*)

bags containing wet clay, or rectangular tin cans filled with clay and chinked with mud may be used. The bags burn but the clay remains in the shape desired. Draught holes should be arranged in the first row of sandbags. Upon them should rest a grating of iron or stout wire fire bars. A very common mistake in making incinerators is to make them of too large a diameter for their purpose. For 1000 men 6 feet diameter and 3 feet 6 inches high is a workable size. For smaller units, a diameter of 3 feet is adequate, the height being the

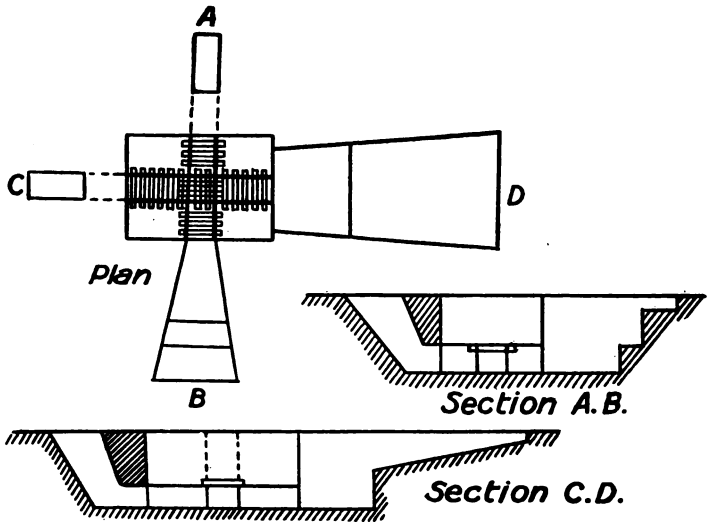

FIG. 98*a*.—Underground incinerator. (*Pike.*)

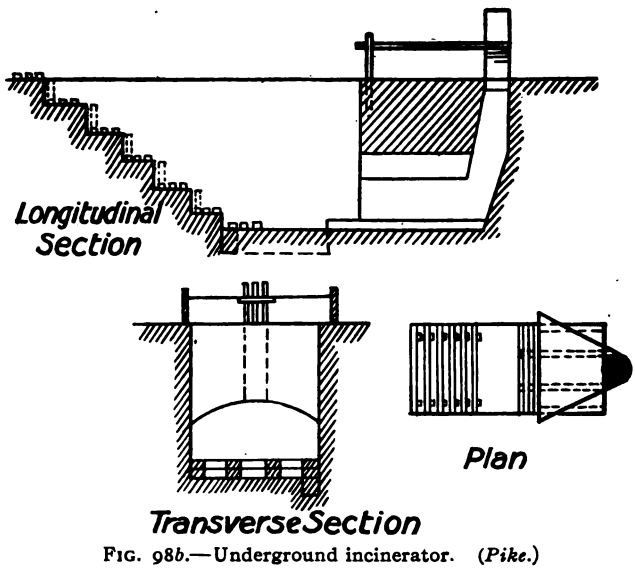

FIG. 98*b*.—Underground incinerator. (*Pike.*)

same as for the larger unit. The illustrations shown are of incinerators made of sandbags, with a cone of corrugated iron, wired to a tripod of iron bars, fixed in the sandbags. The cone affords a powerful draught.

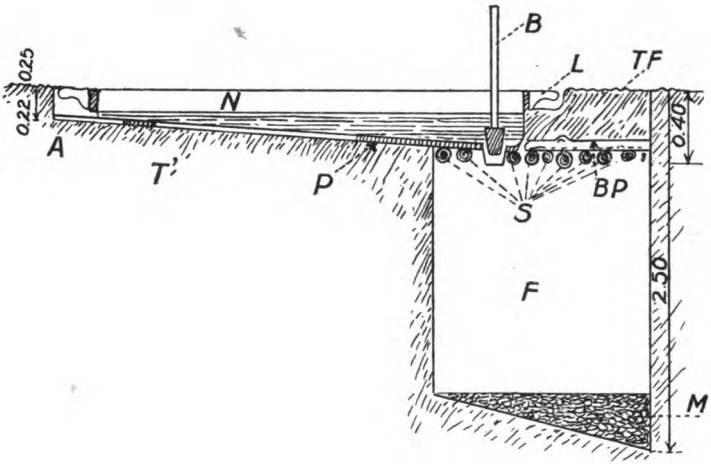

FIG. 99.—Trough latrine and pit. (*After Tournade.*)

Tournade recommends the following for use in immobilized units. Its principle is to receive excrement in an antiseptic fluid and after contact for 12 hours, deliver it into a pit..

A pit is dug from 3 to 6 feet long and 6 feet deep. Perpendicular to one side of it, is dug a ditch 15 inches wide and 6 feet long. Its bottom inclines toward the pit with a 5 per cent. slope. The trench is fitted with a removable metal trough, 2 m. long with a bottom sloping toward the pit. Where it projects over the pit there is a hole normally closed by a leather flanged, wooden plug. This is provided with a long handle. Removal of the plug empties the trough into the pit. The trough is 12 inches wide at the bottom, 15 inches wide at top, its depth at the shallow end is 10 inches, at the deeper end 13 inches. A solution of 4 per cent. cresyl or any other effective antiseptic is recommended. To prevent splashing, the surface is covered with a layer of paper. A better plan is to use a longer, deeper trough of parabolic shape, half fill it with water, and to disinfect the effluent if need be, in the pit. This apparatus is used on some French lines of communication.

Another extemporized incinerator is made of turf. One side of the incinerator may be made of corrugated iron, running in a groove and the other three sides of turf. The advantages of this is

that the incinerator is more readily cleaned. Underground incinerators also are used.

Trinca's incinerator is made of brick or stone cemented by a mixture of clay 5 parts and cow manure 1 part. This is a very binding material. The air space is below ground in order to save material. With an apical opening an intense heat is produced. The tray is perforated to allow liquids to fall on the fuel beneath. Combustible refuse is introduced through "R" then tin cans, and on this manure. Feces are poured in through special chutes F & F′ and evenly distributed over the tray after the refuse has been ignited and is burning freely. It may be kept burning indefinitely. The advantages of this apparatus are that refuse is the only fuel needed, large amounts of material may be burned in a small space, it will consume manure and feces, does not develop offensive odors, and is economical of material.

FIG. 100.—Shelter for horses at Namaquipa, Mexico.

Stables.—Shelter in cold weather and shade in hot should be provided for the welfare of horses and mules. Watering troughs should be provided.

Disposal of Manure.—Picket lines should be ditched and kept policed, refuse being removed daily. They should be burned over weekly with one gallon of crude oil and 15 pounds of hay or straw for each animal.

No grazing should be allowed within 2000 yards of camp.

Manure may be burned in dry climates by spreading an area not more than 4 inches deep where it will not be crossed by wagons.

It is allowed to dry two days and then set on fire. Or it is burned in windrows 2 feet wide and 2 feet high, made by throwing off the manure from the tail of a wagon. They are about 8 feet apart and after drying a few hours they are spotted with oil on the windward side at 6-foot intervals and fired. Windrows are raked to cover a narrow space, to prevent burning feet of animals. The next day the wagons straddle the windrows and dump the manure on their ashes. In wet weather especially it is essential that the windrows be worked over constantly, and the smudge kept going by turning the unburned manure over on to the smouldering part but not in such quantities as to smother it.

FIG. 101.—Windrow method of burning manure. In the foreground piles of manure are made into a windrow.

During the rains when the amount of manure is large, it may be dumped in piles containing 20 to 30 wagon loads, or over the edge of a ravine, at a point not less than two miles from camp. The pile should be ditsant from a through road as passing men and animals bring flies into camp. These piles are liberally sprinkled with oil and ignited, or if over the edge of a ravine, the fire is started at the bottom. The manure is consumed but not rapidly enough to prevent fly breeding. This was the method followed in the Punitive Expedition. Another plan is to spread the manure in a long narrow pile, not more than 12 feet wide at the top nor more than 5 feet high so that successive wagons driving over it may pack it tightly. Each new load is packed tightly by shovels. The British spray the surface and sides with borax solution (¾ lb. to 1 gallon of water).

Lewis and Miller employed the Panama incinerators in the El Paso District with excellent results. These were grates made of railway iron about 30 feet long and 10 feet wide, with a rail 3 feet high. The grate was supported about 3 feet above the ground by concrete or railroad iron uprights on cement foundations. The rails forming the floor were at right angles to the long diameter. The incinerators were placed broadside to the prevailing wind. No

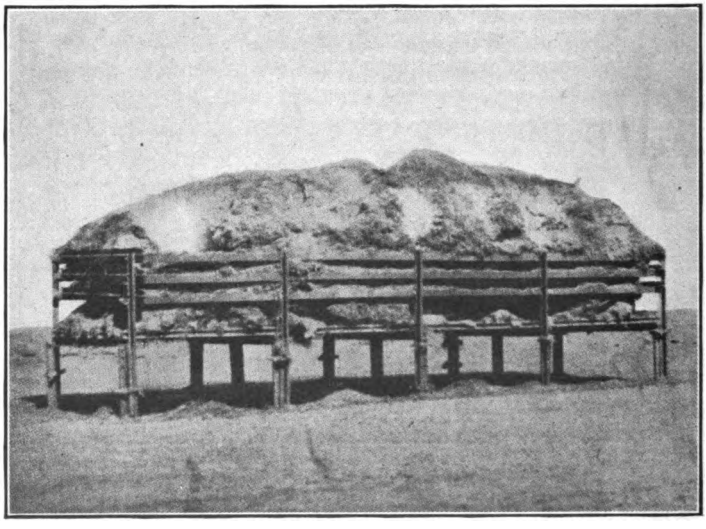

FIG. 102.—Railroad iron or Panama incinerator for manure. This incinerator was partly burned out when the photograph was taken. Ordinarily the manure is piled higher than here illustrated. (*Lewis and Miller.*)

purchased fuel was necessary. A fire started with a refuse box from the dump consumed from 25 to 50 loads a day. This device offered better results than did the windrow method as by the latter some larvæ escaped. It consumed from 25 to 50 wagon loads a day. In wet climates this incinerator should be covered with a galvanized iron roof.

A device for the use of small commands is a cylindrical incinerator made by wiring together sheets of galvanized iron. It is about 5

feet high and 4 feet in diameter. This is placed over the junction of two trenches, intersecting at right angles. These trenches are

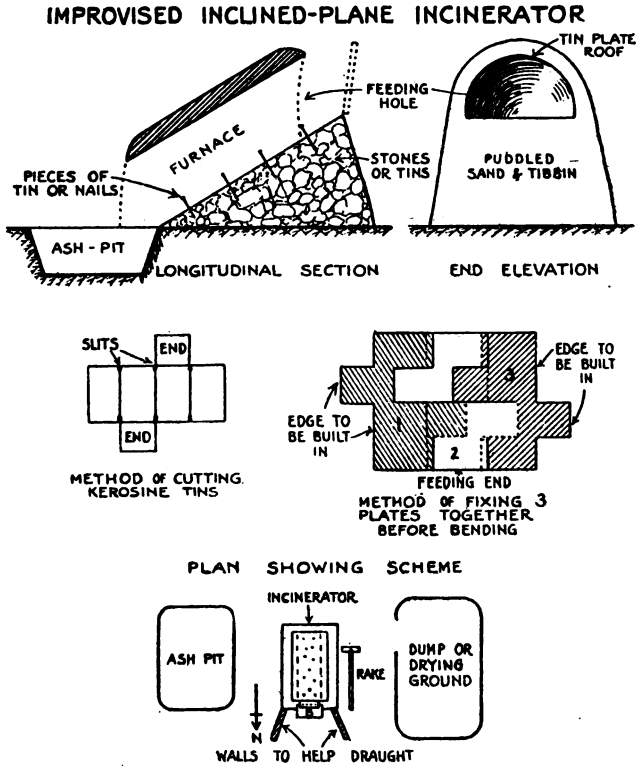

FIG. 103.—Fixed inclined plane incinerator, made of four gasoline or kerosene cans cut and joined by mutually engaging notches cut in the edges. They make an enclosed arch on a base of straw or mud and are covered with mud or tibbin (chopped hay 1 part, mud 7 parts). Nails shown in first part of figure prevent refuse sliding through. Tin plate used over feeding hole according to direction of wind. Two such incinerators can dispose of the refuse (other than feces) of a regiment. (*After Lelean.*)

8 feet long, 1 foot wide and 1 foot deep under the container. Or, instead of trenches, apertures 8 inches in diameter may be made at

opposite sides of the cylinder at its base. A few tin cans should be thrown in to form a grate. In such a cylinder both garbage and manure may be burned. Tin cans distributed in the mass facilitate the draught and a little oil greatly facilitates combustion. In wet weather it should be covered with a sheet of tin. A similar container

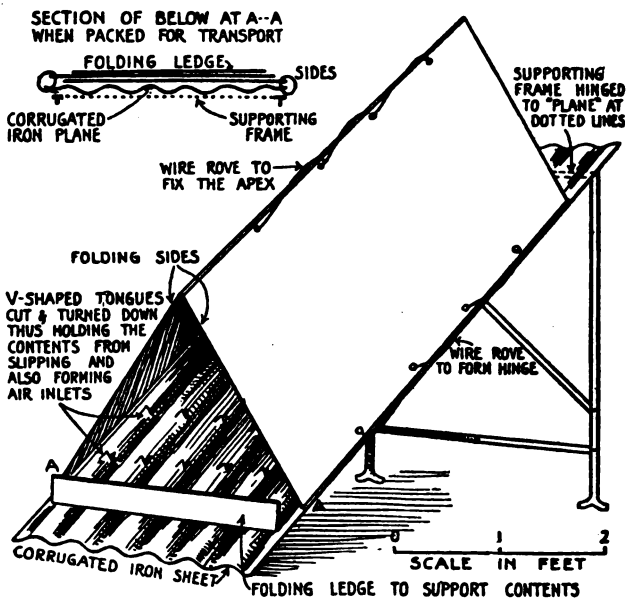
SECTION OF BELOW AT A--A
WHEN PACKED FOR TRANSPORT
FOLDING LEDGE
SIDES
CORRUGATED IRON PLANE
SUPPORTING FRAME
WIRE ROVE TO FIX THE APEX
SUPPORTING FRAME HINGED TO "PLANE" AT DOTTED LINES
FOLDING SIDES
V-SHAPED TONGUES CUT & TURNED DOWN THUS HOLDING THE CONTENTS FROM SLIPPING AND ALSO FORMING AIR INLETS
WIRE ROVE TO FORM HINGE
A
A
CORRUGATED IRON SHEET
FOLDING LEDGE TO SUPPORT CONTENTS
0 1 2
SCALE IN FEET
PORTABLE INCLINED-PLANE INCINERATOR

FIG. 104.—Same principle as above. Apparatus is knock down and portable, can always be turned to face with the wind. Ashes removed through V-shaped apertures in floor by knocking side of incinerator. (*After Lelean.*)

can be made of mud over the intersection of two intersecting trenches. Another device for a small command is a wire frame or grid with meshes 5 inches square. It is about 4 feet cube and is supported 2 feet above the ground.

Yet another device is a mud or brick chamber 10 × 8 × 14 feet employing a grate. Stoke holes are provided in the sides. These

are about 15 inches square and are on the ground level. Manure is thrown in through a two foot aperture in the top, covered by a removable lid. A fire is started before the manure is thrown in, and after it is burning briskly, the dampers are closed. Ashes are raked out from under the grate.

In the British service at some places on the western front, manure is placed in long piles and covered with a foot of earth. In others it is destroyed with rubbish in mud or galvanized can incinerators.

The reduction of fly breeding by means of chemicals has as yet found no place in our military service. Chemicals recommended for this purpose by the Department of Agriculture are the following:

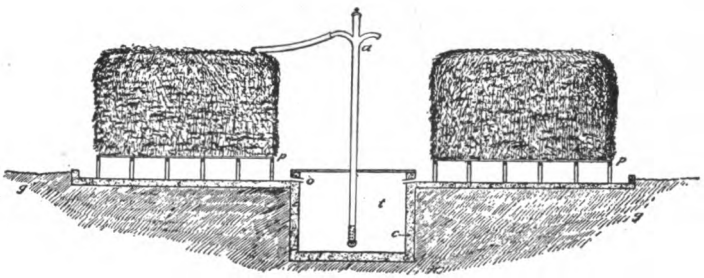

FIG. 105.—Imaginary cross-section of an arrangement, suggested for trapping maggots, for use where manure production is large: *a*, Pump; *c*, concrete floor and walls of cistern; *o*, outlet pipes leading from floor of maggot trap to cistern; *p*, platform maggot trap; *t*, cistern for liquid manure; *g*, ground level. (*Hutchinson.*)

Borax may be scattered on the surface every two or three days, in the proportion of 3 lbs. to 40 bushels of manure.

The following solution, viz.: sod. arsenitis 1 lb., brown sugar 10 lbs., water 10 gallons, may be scattered at frequent intervals. It kills adult flies who come to lay their eggs.

A later recommendation is to apply one pound of calcium cyanimid and two to four pounds of acid phosphate per square foot of surface, or 4 pounds of cyanamid and four or more pounds of acid phosphate for eight bushels. This process both destroys the flies and increases the fertilizing power of the manure.

A method for the destruction of larvæ, with conservation of

manure, is indicated by the diagram. Larvæ leaving the manure pile to pupate are caught in a water filled cement pit and drowned.

Camp Police.—There should be a daily police of camp, the site of each organization being cared for by it, and communal areas being cared for by a detail or employees under a qualified supervisor. A tin can in front of each tent should collect the refuse discarded by its occupants. Refuse should be hauled to the dump.

FIG. 106.—Rubbish dump. The only exposed rubbish is along the advancing margin of the pile. The top of the dump is entirely covered over and smooth. (*Lewis and Miller.*)

"This should be kept in a very restricted area. It is built up to a very considerable height (10–15 feet) by successive layers. Tin cans, bottles and such combustible material as is not disposed of in the manure incinerator are dumped over the edge of the bank which is formed as the pile progresses. A fire is kept burning along the advancing edge of the pile and if the rubbish and tin cans are properly interspersed, all combustible material will be consumed. The ashes from kitchen ranges are deposited on top of the burned tin cans as the pile advances. The dump must be compact; tin

cans are not left uncovered and animals are not allowed to pass over exposed bottles or other débris which might injure their feet. The photograph shows a dump made up of incombustible rubbish. There is no rise of ground in the vicinity." (Lewis and Miller.)

In the camp at Columbus, N. M., the "cake tin incinerator" was used.

Dead animals are usually buried. Lelean recommends a modification of this practice. A pit is dug beside the animal, which is eviscerated and the viscera buried. The carcass is dragged over the pit, 40 lbs. of hay or straw are placed in the cœlum and over the

FIG. 107.—Cake tin or cone incinerator.

surface. This is wet with a quart of kerosene and fired. The method aims at charring the surface of the animal and sterilizing the soil fouled by the blood.

Bivouacs.—On marches and in the presence of the enemy troops often are obliged to bivouac. From a tactical point of view bivouacs are convenient, but for sanitary reasons are resorted to only when necessary. The general principles governing selection of camp sites apply with even greater force to those for bivouacs. The ground should be dry and protected from both sun and wind. Light woods are nearly always good sites. To reduce the force of winds, windbreaks may be constructed, either by brush, sloping with the wind at an angle of 45 degrees, or by a bank of earth 3 feet high. The trench from which it is taken should be on the outside of the protected area. A circular enclosure 15 feet in diameter with a fire in its center promotes comfort. The men lie with the feet to the fire.

Billets.—When troops are likely to remain many days or weeks along a line of fire confronting the enemy, they should be encouraged to make themselves as comfortable as possible in the trenches by timbered dugouts, etc., and should be relieved by fresh troops at short intervals. The interval on the western front is (usually) two weeks. In such case, the troops when relieved should make every possible use of local buildings, erect temporary structures and should have available additional camp equipments, tents, surplus kits, etc., sent up from the line of communication, and should not be billeted in houses if this can be avoided, lest they contract infections from the inhabitants. If billeting is practised, however, houses and occupants should have been inspected by a medical officer, and the doors of those habitations harboring infection, marked in a distinctive manner, *e.g.*, by red chalk. To prevent imitation by civilians who do not wish their houses occupied, a record should be kept of those marked and verified at intervals.

Unless the force billeted is small, it usually has to be distributed among several buildings. This has a demoralizing effect on discipline with a consequent effect on sanitation. Also the public and private sanitary conditions in small towns frequently are very unsatisfactory. But billets can be kept in a cleanly condition by standing orders, frequent inspections, and detailed supervision. Since the billets on the western front are occupied alternately by bodies of troops which relieve each other in the trenches, there is no opportunity and small incentive for cleaning them properly. Frequently they are infested with vermin. Constant efforts must be maintained to destroy vermin and their eggs, for reinfestation of billets often occurs, when troops come in from the trenches.

The methods used to destroy lice and fleas are discussed elsewhere. Bed bugs may be destroyed by successive fumigations at 3 day intervals as the eggs may not be destroyed by one fumigation alone. The agents most used are sulphur, one pound to each 1000 feet; pyrethrum, five ounces per 1000 feet; or camphor and phenol equal parts, four ounces per 1000 feet. Formaldehyde is unreliable. If fumigants are not available employ a spray of benzine or gasoline or paint surfaces with a 25 per cent. emulsion of petroleum in water. Infested clothing and bedding should be steamed.

CHAPTER V

WATER

Quantity.—The approximate quantities of water needed per man per day are as follows:

For drinking only (minimum)	3 pints
For a day's march and bivouac or one night camps (for drinking and cooking only)	1 gallon
Camp where no clothing is washed	3 gallons
Camp where clothing is washed	5 gallons
Fixed camp where water is piped	25–30 gallons

In fixed camps with piped water supply, the number of gallons required is computed as follows:

Drinking.....1, Cooking.....2, Ablutions.....2, Laundry .....8, Shower.....5, Water closet.....6.

The quantity of water required per horse or mule per day is from 6 to 10 gallons on the march or in camp, but in hot or dry weather this is sometimes increased to 15 gallons. Mules need less water as a rule than horses, and 6 gallons usually will suffice.

To estimate the quantity of water yielded by a stream, the following formula is used:

$$B \times D \times V \times 10{,}800 = \text{gallons in 24 hours.}$$

In this formula, B is the breadth of the stream; D is the average depth; V is the average velocity. This average velocity is four-fifths of the surface velocity, which is determined by noting the time that it takes for a floating stick or chip to traverse a measured length of the stream. The available output of a stream is increased by constructing dams.

A gallon of water weighs 8 lbs. 3 ozs., and contains 231 cubic inches. A cubic foot of water weighs 62½ lbs. and contains 7½ gallons.

The capacity of a cylindrical vessel in gallons is the product reached by squaring the diameter in inches, and multiplying this product by the length in inches, and by the fraction 0.0034.

The quantity yielded by a well is estimated by rapidly lowering its surface by a measured depth, and noting the time it takes for it to refill. The volume of water in this space in cubic feet is the product of this depth by three-fourths of the square of the diameter, all in feet.

Sources of Water.—The purest water is rain water. It always carries some slight constituents and impurities of the atmosphere, especially coal, sand, coal dust and a minute quantity of organic matter including a few bacteria. Rain water is highly aerated, wholesome and palatable. It is very soft, an excellent solvent of soap, well suited for washing and cooking purposes. In the field in the tropics, it is often caught in troughs made of split bamboo from which the joint partitions have been removed. These are hung under the eaves of a tent or hut and carry the water into containers. The first portion of the rainfall is more or less contaminated and should be rejected if rains have been infrequent.

Springs are classified as land or main springs. The former discharge water that has percolated into the earth until it has met an impermeable stratum; the latter are the outlets of subterranean reservoirs which lie between two impermeable strata. The former are intermittent and their output is occasionally polluted, since the soil has not strained out the bacteria carried down from the surface. Whether they are contaminated or not may be judged with a fair degree of accuracy after inspection of the area which they drain. Main springs are continuous and their output usually is pure. Springs in chalk or limestone formations should be regarded with suspicion as they are frequently mere outcroppings of streams that may have been polluted some miles away and have disappeared below the point of contamination. Cracks and fissures in a rock formation, especially limestone or chalk, may lead from a privy to a distant outlet.

The output of a spring may be increased by digging it out and lining it with wattle-work, an empty box or barrel from which both top and bottom have been removed, or by brick and stone. Surface drainage is kept off by a trench or a rim of clay.

The water from streams draining inhabited areas should always be considered unsafe for drinking purposes until it has been purified. Streams are contaminated both by surface washings and by the deliberate usage of them as a means for removing sewage from adjacent habitations. This pollution is greatest in the Spring, when melting snow and abundant rains wash down sewage that has accumulated for several months. In countries having a dry and a rainy season, the water is most polluted at the onset of the rains. At this time intestinal disturbances are most prevalent. The water

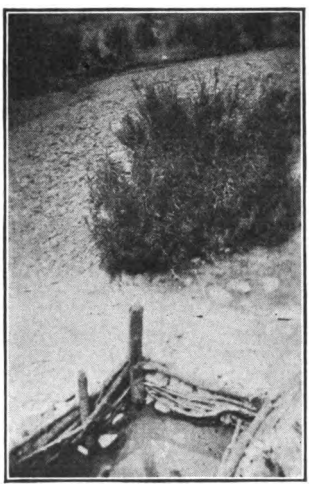

FIG. 108.—Well with wattled walls sunk in sandy bank of stream.

in streams is highly complex, the composition varying according to the geological nature of the water-shed drained and the nature and degree of pollution it has undergone. It practically always contains animal matter in suspension. Though river water undergoes spontaneous purification, so that from twenty to fifty miles below a city it may be almost as pure as it was above it, such purification should not be relied upon. This purification is effected by sedimentation, dilution from tributary streams, solar action, oxidation and biological action, which is probably the most important factor.

The most active biological elements are the nitrifying bacteria, which break up organic matter into simpler bodies. Their action is increased by falls and rapids which favor oxidation.

Lake water has much the same character as river water, but is more free, as a rule, from serious organic impurities. In large lakes, the dilution of accidental contamination renders this practically negligible, but does not compensate for and control deliberate and systematic pollution. Small lakes or ponds, because of the smaller volume of water contained by them, are proportionately more liable to serious contamination than are great ones.

Wells were formerly classified as shallow or deep, but this standard is now discarded. The most important elements in determining the purity of well water are:

1. Whether it traverses an impermeable stratum.

2. Whether in chalk or limestone formation a fissure conducts into it deleterious material from some neighboring or distant point.

Drainage from a source of contamination, *e.g.*, a latrine into a well or spring, can be determined by the fluorescin method. The strength of the solution used is twenty grains to five gallons of water. The solution must be rendered alkaline by the addition of chemically pure sodium bicarbonate. Large quantities of the solution may be placed in the suspected latrine, but better, a hole may be dug adjacent to it and twice this amount of the solution thrown in and washed through with several buckets of water. The well should be pumped and the water tested at intervals of half or quarter of an hour beginning fifteen minutes after fluorescin is placed in the hole. The water in the well is tested by looking at it through a depth of one foot in a glass tube or jar against a white background. A green tint should show very distinctly in a dilution as high as one part in ten million. A stronger solution of fluorescin can be used if necessary.

Wells are usually polluted from the surface and not from the subsoil drainage as is generally supposed. The filtering power of the soil is usually sufficient to protect against pollution, unless the soil is overburdened with organic matter, or a cesspool or broken sewer, etc., is very close, or fissures exist in the soil and subsoil through which impurities may pass. Surface configuration, character of soil and proximity of sources of pollution should be

examined to determine the purity of the water, if the fluorescin test is not available. A source of possible contamination is determined according to its distance from the well. Several standards have been used, *e.g.*, a distance of 50 feet from the mouth of the well, or a radius of from 2 to 4 times the depth of the well according to the character of the soil, or daily fall of water in the well, or 150 times the distance which the water in the well is lowered by one hour's pumping.

Requirements of a well are the following:

1. Deep enough to secure efficient filtration of the water entering it.

2. Lined with cement, or stone or brick set in cement, so that the water may enter only at the bottom.

FIG. 109.—Tube well.

3. Provided with a coping of cement sometimes carried up 2 or 3 feet to prevent entrance of water around the top.

4. Protected by a water and dust-proof cover and a pump, which should be at one side of the well and not over its center.

Tube wells consist of several lengths of iron piping about 4 inches in diameter. The lowest length is pointed. At each end of each

length are grooves which engage a collar, by means of which the lengths are successively screwed together, as the preceding length is driven into the ground. These wells can not be driven even through moderately hard rock. A pump is screwed to the upper end when water is reached, but it can raise the water only 25 feet. The output is at first turbid, but later becomes clear. The use of such wells is restricted by the fact that each weighs 1400 pounds.

If no other suitable sources of supply are found, tube wells are often driven by troops in field service in fixed camps. The most common sites for these are at the base of the steeper side of a valley; the bottom of gullies or gulches, especially just below the point where two of them join; the lowest depression in a broad valley or plain; the point where vegetation is greenest, insects most abundant, or where the morning mist hangs longest. Also they are driven at low points on the banks of streams since the soil filters the output, making it purer than water from the streams.

The diseases caused by polluted water are mentioned in the chapter on transmissible diseases.

Protection of Water.—Whatever its source, the water supply should be guarded rigorously. When several commands are placed along a stream, this guard is regulated by the senior officer present. Water for troops is obtained at a point above that used by animals, and the point for bathing purposes is below it.

Examination of Water.—The purity of a sample of water cannot be determined except by laboratory examination. Impure waters almost invariably have a color varying from green to yellow or brown when examined through a depth of two feet but on the contrary, not all waters of such colors are polluted. Many waters that are clear and pleasant to the taste are infected, while per contra colored water may not contain pathogenic bacteria. Some unpleasant waters, containing salt, magnesia, iron or sulphur are not unhealthful. Odor is no criterion of purity, for some waters that are malodorous because of inorganic substances, diatoms or algæ, are not detrimental to health. Most odors are suspicious however, especially if of animal origin and of an offensive putrescent character. Odors are more readily detected if the water is heated and shaken in a half-filled bottle.

The sources of the water supply should if possible, be examined by

an expert and marked good or bad. This is imperative in countries infected with cholera or other harmful bacteria. It is also essential in territory vacated by the Germans since they poison the wells. For the purpose of making such examinations, most services are now equipped with motor laboratories. What is better for the purpose is a portable outfit weighing about 100 pounds, employed in the British service. It consists of a sampling cabinet which can be carried by hand to the well, and is enclosed by a double casing of tins which are utilized as incubator and sterilizer. Accessories necessary for the examination of 500 samples are carried in a separate box. Sixteen samples of water can be examined continuously, providing eight test tubes for each sample; one of agar for the total count and seven of McConkey's taurocholate-lactoro-litmus broth. The size of the samples tested ranges from ½ to 20 c.c. and totals 50 c.c.

The number of bacteria in water is less important than the kind. An arbitrary standard which is a good general working rule, is that good drinking water should not contain more than 100 per cubic centimeter, but in applying this rule the source of the water should be considered. The kind of the bacteria present, *i.e.*, whether they are pathogenic or not, is indicated to a degree by the temperature at which they thrive. Those which grow at 37°C. are of more interest than those which grow at 20°C., while those that grow at 40°C. include the typhoid bacillus and other water-borne pathogens. The following maximum limits of bacteriological impurity have been adopted by the United States Public Health Service:

1. The total number of bacteria developing on standard agar plates, incubated 24 hours at 37°C., shall not exceed 100 per cubic centimeter. Provided, that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.

2. Not more than one out of five c.c. portions of any sample examined shall show the presence of organisms of the bacillus coli group when tested as follows:

(*a*) Five 10-c.c. portions of each sample tested shall be planted, each in a fermentation tube containing not less than 30 c.c. of lactose peptone broth. These shall be incubated 48 hours at 37°C. and observed to note gas formation.

(*b*) From each tube showing gas, more than 5 per cent. of the closed arm of fermentation tube, plates shall be made after 48 hours' incubation, upon lactose litmus agar or Endo's medium.

(*c*) When plate colonies resembling B. coli develop upon either of these plate media within 24 hours, a well-isolated characteristic colony shall be fished and transplanted into a lactose-broth fermentation tube, which shall be incubated at 37°C. for 48 hours.

For the purpose of enforcing any regulations which may be based upon these recommendations the following may be considered sufficient evidence of the presence of organisms of the Bacillus coli group.

Formation of gas in fermentation tube containing original sample of water, (*a*).

Development of acid forming colonies on lactose litmus agar plates or bright red colonies on Endo's medium plates, when plates are prepared as directed above under (*b*).

The formation of gas, occupying 10 per cent. or more of closed arm of fermentation tube, in lactose peptone broth fermentation tube inoculated with colony fished from 24 hour lactose litmus agar or Endo's medium plates, (*c*).

These steps are selected with reference to demonstrating the presence in the samples examined of aerobic lactose-fermenting organisms.

3. It is recommended, as a routine procedure, that in addition to five 10-c.c. portions, one 1-c.c. portion, and one 0.1-c.c. portion of each sample examined be planted in a lactose peptone broth fermentation tube, in order to demonstrate more fully the extent of pollution in grossly polluted samples.

Purification of Water.—The water supply of a camp should be wholesome for drinking purposes without further purification. This is not always obtainable and purification is necessary. Water may be purified by boiling, filtration, chemicals and ultra-violet light.

The simplest method of purifying bad or suspicious water in the field is by boiling it for twenty minutes, although a temperature of 165°F. for 10 minutes will destroy all ordinary parasitic germs. This latter method requires less time for heating and cooling, less fuel and causes less loss of gas. Its advantages are that it requires no special apparatus except a thermometer. The disadvantages

of boiling are the length of time necessary for water to boil and to cool, its consequent flat, insipid taste (unless it be aerated by pouring it repeatedly from one vessel to another, which should always be done) and especially the quantity of fuel necessary. To overcome these objections various kinds of apparatus have been devised none of which is now in use in our service though yet employed in foreign armies. They are essentially similar. Raw water is boiled by petroleum or other fuel, and made to pass into a compartment, separated by a thin diaphragm from that which the raw water occupied before it was heated. This causes a rapid ex-

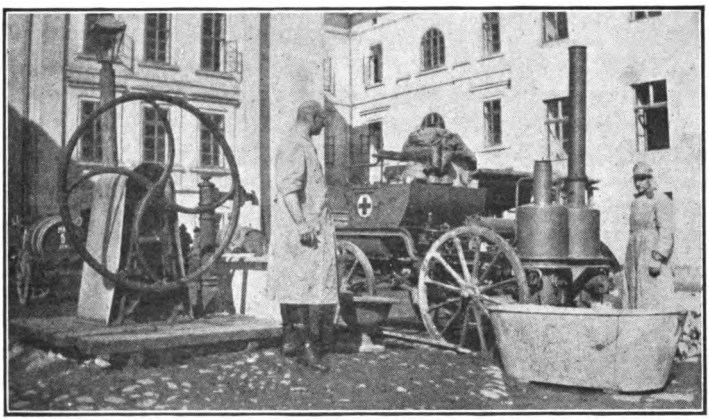

FIG. 110.—Hennenberg water sterilizer.

change of heat, the raw water being warmed, the purified water cooled. In the Philippines a type of this apparatus was provided for the service of each company. Though somewhat complicated it gave great satisfaction. It weighed 96 pounds, burned one quart of oil in 3 hours and had an output of 30 gallons per hour. In several European armies larger apparatus using the same principle is mounted on wheels. The water undergoes a preliminary filtration, is heated, and carried into the cooling chamber by ebullition and expansion. This wheeled apparatus gives an output of from 350 to 400 gallons an hour. Types of such apparatus are the Forbes and the Griffith in the British Army, the Hennenburg in the

German and Austrian and the Gaillard des Maroux in the French. In the Griffith apparatus, water is raised to a temperature of 180 degrees when a valve is opened automatically and the water is allowed to pass to a cooler. The objections to these wheeled sterilizers are their cost, weight, limited output, and their necessity for fuel that may not be obtainable. Their use appears to be restricted to the line of communication or positional warfare.

In the field filtration has been attempted by the Maignen, Pasteur and Chamberlain and Berkfield filters, depending respectively upon the arresting powers of asbestos and charcoal, unglazed porcelain, and infusorial earth. The objections to all of these are their liability to become infected, to pass impure water and to clog. Fragility and limited output are further deterrents to their use in the field.

Filtration by sand has been practised by placing a box or barrel inside another, the inner receptacle being open at both top and bottom. Sand filled both inner and outer receptacles to about one-fourth their height. Water was usually poured into the inner receptacle whence it passed through the layer of sand and rose to its proper level in the outer barrel, from which it was drawn off by a faucet. This apparatus clarified water, but did not remove all bacteria. Also it was liable to become infected, unless fresh sand was used frequently, so that the output was worse than the intake.

The efficiency of filtration by sand depends upon the formation of a gelatinous layer, due either to natural agents which produce zooglea, or to aluminum hydroxid which is formed when alum is thrown into water. The defects in the filtration plant which used two barrels or boxes may be overcome by using sand which has been purified in sterile water, and by precipitating a layer of aluminum hydroxid upon the surface of the sand in the inner receptacle. In the operation of such a purification plant it is essential that the gelatinous filtering layer be not disturbed and that this sand be cleansed at least every other day. Water must be introduced into the inner receptacle gently, preferably through a syphon whose discharge end is turned upward, otherwise the value of the apparatus is destroyed.

Filtration through sand and a layer of aluminum hydroxid may also be practised by digging a trench near a stream, lining the trench

with puddled clay and two revetments, one between the trench and the stream, and the other on the further side of the trench. The trench is partly filled with successive layers of small stone, gravel and sand, and on these a layer of flocculent gelatinous aluminum hydroxid. The water from the stream is led into the trench by a syphon, whose discharge end is upturned in order that the filtering surface may not be disturbed by the flow of water. The filtered water is drawn from the trench through a pipe which passes through

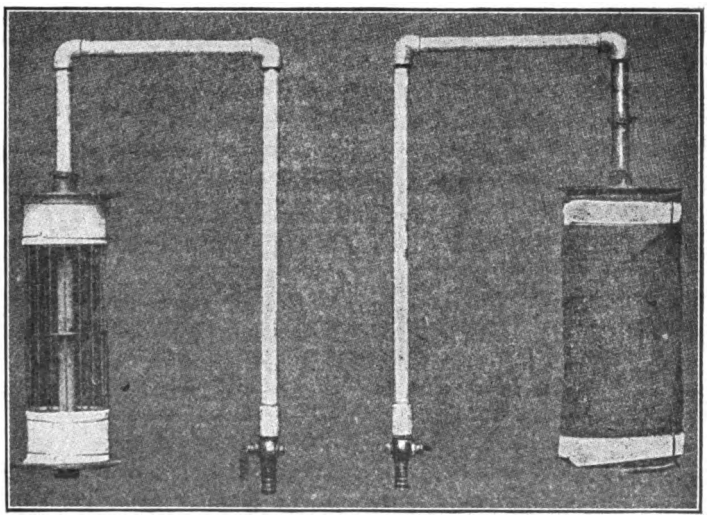

FIG. 111.—Filtering apparatus of Darnall filter. (*Havard*)

the outer revetment and into the layer of small stones. This method can be followed to advantage only where the geographical situation is unusual, *i.e.*, when one bank of the stream is higher than the land near it, as the lower side of an irrigation ditch.

A much simpler and quite satisfactory procedure is to dig a pit near the side of a stream, and dip from it the water that seeps through. Such water has been strained by the natural zooglea in the stream bed as well as by the intervening soil. In semi-perma-

nent camps this pit may be lined with wattle work, or a barrel, keg or box, from which both ends have been removed.

Several other more elaborate devices utilize the straining effect of aluminum hydroxid. The best of these is the Darnall filter, which consists of a syphon with a cylindrical metal framework surrounding its ascending arm; a cloth which surrounds this framework and is the essential part of the filter; a syphon primer, two water cans, a galvanized iron tank and a crate. The precipitant consists of alum hydroxid and sodium carbonate in proportions which satisfy each other chemically. Five grains of alum to the gallon are suffi-

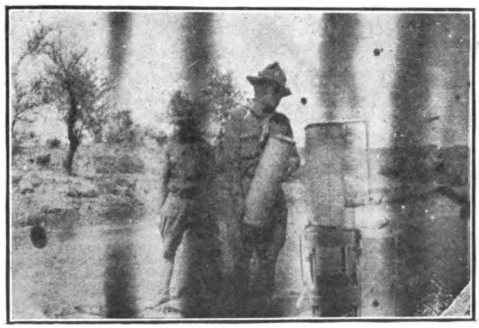

FIG. 112.—Darnall filter in operation.

cient to clear the most grossly polluted water. When the precipitant is added to water a flocculent precipitate is formed which entangles parasites and arrests them on the surface and in the body of the filtering cloth. This becomes clogged eventually and must be removed and brushed, but as the output continues to diminish, the cloth is removed, washed, boiled and dried. Meanwhile it is replaced by another. This apparatus removes 98 per cent. of the bacteria in water; clarifies it and will deliver 50 gallons of water an hour. It weighs 52 pounds, and is quite the best apparatus yet devised for filtering water in the field.

The Japanese field filter (the Ishiji filter) consists of a conical canvas bag having a capacity of 24 gallons and with two spouts or branches just above the apex. These spouts contain sponge disks

which effect filtration. The apex of the cone receives the sediment. This filter employs two powders, the first consisting of potassium alum, potassium permanganate, aluminum silicate, the second chiefly of aluminum silicate and small amounts of tannic and hydrochloric acids. After the filter has been filled a suitable quan-

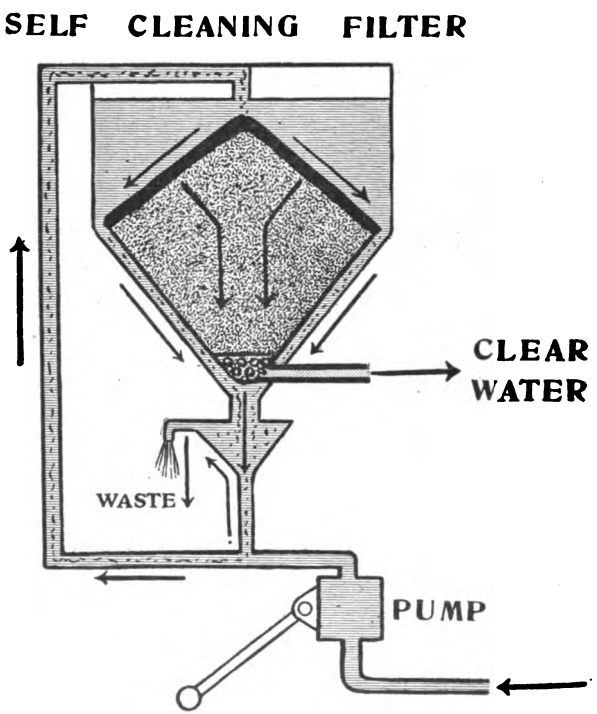

FIG. 113.—Sand and alum filter. (*After Lelean.*)

tity of the first powder (enough to plainly discolor the water) is added and stirred up. After a few minutes about one-half as much of the second powder is added and stirred until the discoloration caused by the first has been removed. After the precipitate subsides, in 15 or 20 minutes, the leather spouts are untied and the

water allowed to pass. The hydrochloric acid assists the decomposition of the permanganate while the tannic acid removes the color. The result is satisfactory with clear water but much less so with turbid water. A modification of this process is to place in the radial spouts perforated boxes containing alum, silicon, potassium permanganate and charcoal. As the water passes through it forms aluminum hydroxid which is arrested by the sponges and helps their filtering action.

A sand and alum filter which may be extemporized in camp consists of two concentric inverted cones or pyramids, separated by a narrow interval. The outer receptacle is extended upward as a cylinder or rectangular box to form a tank. A pipe drains the drinking water from the bottom of the inner receptacle, and another pipe drains the waste water from the apex of the outer one. The inner receptacle is filled with a heaped-up quantity of sand, and this is covered by a layer of alum hydroxid. Water is poured gently into the tank. Gross impurities roll down the sides of the heaped-up filtering mass and escape in the waste water, which may be poured in again after sedimentation.

If no filtering apparatus is at hand, but alum and sodium bicarbonate are available, the addition of five grains of the former and one and one-half grains of the latter to a gallon of water will clarify the muddiest water in one or two hours and carry down 95 per cent. of the contained bacteria.

Chemical Sterilization.—The most generally satisfactory means of purifying water in the field is the use of chlorinated lime—the so-called chloride of lime. This is a lumpy powder, made by saturating slaked lime with chlorine. It should contain 35 per cent. of this gas available for use. By available chlorine is meant the amount that is liberated readily from its combination in the powder. The chlorine content diminishes rapidly on exposure to air. A percentual calcium chloride carrying 75 per cent. of chlorine is advocated but is not now obtainable in America. Its advantages are greater stability, and the smaller amount of the chemical necessary for a given result. The germicidal value of calcium chloride is due to the action of carbon dioxid in water upon the calcium hypochlorite in the powder, producing hypochlorous acid which in turn liberates oxygen, and develops chloramines.

It is the nascent oxygen and more especially the chloramines which destroy bacteria and not the chlorine content of the calcium chloride, as such.

The amount of chlorinated lime which must be used to purify water depends upon the strength of the former and the composition of the latter, particularly in reference to the amount of organic matter the latter contains. In water containing little organic matter bacteria will be reduced 99 per cent. by 1 part per million, but for a similar reduction in sewage 1 part per 25,000 is necessary.

FIG. 114.—Lyster bags supported by stacked litters.

When impure water containing organic matter is attacked by hypochlorites, it develops unpleasant flavors; therefore it should undergo filtration through several layers of cloth before the powder is added to it. Five parts of powder per million parts of water are usually considered adequate, but if there is grave danger of pollution, more should be added. Havard recommends for general field service from 5 to 15 parts per million. Lyster controls deterioration of the powder by preserving it in brown glass capsules which are broken just before use. In order to effect a percentual certainty one tube is provided for each bag of water containing 40 gallons. Each tube

contains 15 grains, giving two parts of available chlorine for a million parts of water. The Lyster water bags are made of rubber lined canvas, with a hemispherical bottom to receive sediment and 6 spring faucets are placed around the bottom of the bag just above this hemispherical portion. These bags have given excellent service in Mexico and along the border. Improvements recommended in the bag are that it be made of heavy canvas and provided with a cover preferably of a filtering material that can be tied over the top, used as a strainer, removed and boiled. Another modification suggested is that the bag be made in half sizes so that platoons operating independently may be equipped. The manner in which the powder is added is important. It should not merely be thrown into the water but should be first made into a paste, all lumps being carefully broken up, then thinned to a dilute suspension, and then stirred into the water to be purified. The contents of one of the Lyster tubes should be thinned by the gradual addition of at least a pint of water before it is stirred into the water in the bag.

Parties not supplied with measured quantities of the powder use the following method recommended by Havard: A teaspoonful is leveled off by rolling a pencil over it, rubbed up with a cup of water, and diluted with three more cupsful. A teaspoonful of this dilution is thoroughly mixed in a 2-gallon pailful of water. This water should not be drunk for at least an hour after the chloride has been added.

Disadvantages of the hypochlorite method are that it increases the hardness of water and may give it an unpleasant odor and taste. The formor objection is more theoretical than practical. The latter may be overcome by agitating the water.

The advantages of this method are cheapness, quickness, convenience and general reliability.

A portable plant weighing 222 pounds for the hypochlorite treatment of piped water supplies has been devised by H. A. Whittaker. It will treat satisfactorily 1,000,000 gallons a day which can be increased to 4,000,000 with added effort on the part of the operators. Its use in the military service is restricted to fixed camps or billets with piped water supply of doubtful purity.

Sodium hypochlorite is slightly more efficient than the calcium salt and forms less precipitate but it is more expensive.

Sodium bisulphate is an excellent agent for sterilizing water in canteens. For that reason it is of peculiar value in the cavalry service whose equipment must be as scant as possible and where small detachments operate without apparatus for purifying water. Thirty grains should be added to each quart. Firth recommends that it be made up in tablets with saccharine and oil of lemon. The water should not be drunk for about 20 minutes. This agent can be used only in aluminum canteens as it forms toxic sulphates with other metals.

Calcium permanganate has been used recently in the German army to purify the water in canteens in the proportion of about 1 grain to the quart. A tablet containing the salt is dissolved in a canteen full of water agitated and allowed to stand for 10 minutes, when a tablet of manganous sulphate is added. A precipitate forms which must be filtered off by a filter paper cap over the mouth of the canteen. The disadvantages of this method are the fragility of the filter paper cap, the possibility of confusing the tablets and the time interval which thirsty soldiers would be prone to abbreviate.

Potassium permanganate has been used to purify water in the proportion of a grain to the quart. As a workable rule, enough is added to give the water a pinkish tint. Its effects are due to the nascent oxygen liberated but its action is weak, very slow, somewhat uncertain in the strength used, and it imparts an unpleasant taste and color to the water. Its use is restricted usually to purifying waters supposed to have been infected with the B. choleræ which is peculiarly susceptible to its action. Wells are disinfected by adding potassium permanganate in the proportion of 60 grains to the gallon. After 24 hours the water is pumped until it is colorless. Dead aquatic flora and fauna should be removed.

Copper sulphate destroys algæ in water in the proportion of one part per million, but it will not destroy pathogenic organisms except in such strength (one part to 50,000) that it would be toxic to persons drinking it.

Iodine liberated from a mixture of iodide and iodate and after an interval removed by sodium hyposulphite has been used for sterilizing water in canteens in the French army. The agents were put up in red, white and blue tablets in order to make them easily distinguishable. Because of the fact that the first two must be crushed

together before they were added to the water and because of the time interval—ten minutes—that had to be allowed before the third was added their use has been discontinued.

Dakin and Dunham report that the most suitable substance for sterilizing drinking water in the field is one which they have devised, viz., p-sulphon dichloramino benzoic acid. As the synthetic name is cumbersome, the term halazone[1] has been proposed for the tablets containing it ($Cl_2N.O_2S.C_6H_4.COOH$). These are easily prepared from cheap, readily available materials and are reasonably stable. One part of the agent per 300,000 will sterilize an ordinarily heavily contaminated drinking water in about thirty minutes destroying b. typhosus and b. choleræ, etc. In this concentration a very slight taste is perceptible, especially in warm water containing little organic matter, but the water is perfectly palatable. The active chlorine is utilized less rapidly than that in bleaching powder, for which reason the disinfection process continues for a longer period. By the use of this agent fifty gallons of water can be sterilized for one cent. Its action on aluminum is negligible.

Ultra-violet Light.—Ultra-violet light has been used to purify water in the French and Austrian services but its development requires the use of bulky apparatus, parts of which are very delicate. Also its value is much diminished in turbid waters or those containing colloid material. Its use in the field has not proven practicable.

Several methods have been employed for carrying water to troops at points where this is not readily accessible. The Hennenberg sterilizer is provided with a water cart. A cart which both purifies and retains the water is used in the English service. In the Austrian service a small native wagon in the service of each company carries barrels. The French employ a water train and also have steel water wagons, each weighing 1200 kg., and carrying 3000 kg. of

[1] The starting point, in the production of this agent is the development of p-toluene sulphonamide by the action of ammonia on p-toluene sulphonic chloride. This last mentioned is a very cheap waste product in the manufacture of saccharine and is obtainable in relatively large quantities.

A description of the technique followed to produce halazone is believed to be out of place here. It can be found in the article by Dakin and Dunham on page 682 of the British Medical Journal for May 26, 1917.

water. Each wagon has a purifying capacity of 3000 litres per hour and can supply 25,000 to 30,000 litres per day. Fifty feet of woven wire hose are supplied. The wagon is divided into two equal compartments. Chloride of lime is used for the purification of the contents.

Lyster has recommended for use in our service a canvas tank which would fit the body of an escort wagon. It would be provided

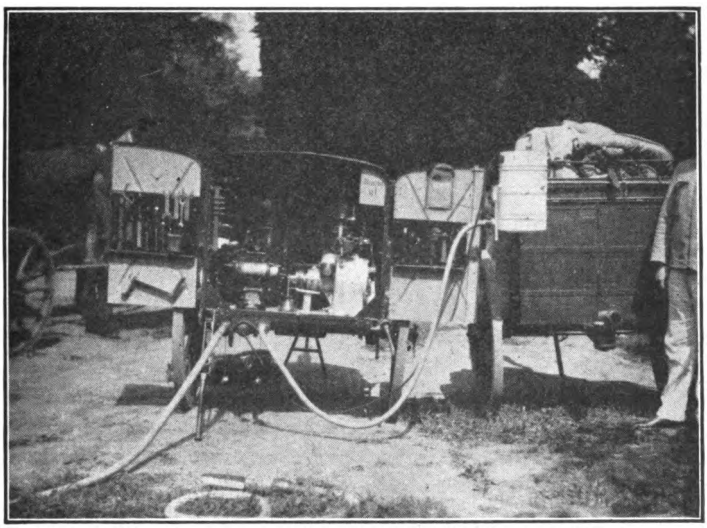

FIG. 115.—Field apparatus for sterilizing water by ultra-violet light. (*Austrian Service.*)

with spring faucets similar to those used on the water bag he devised. It has also been recommended that a flat water tank be fastened to the bottom of the company wagon. This should be provided with spring faucets at the rear of the vehicle, from which men may replenish their canteens.

The necessity for some such apparatus was often keenly felt by the troops in Mexico, where the heat and aridity conspired to increase thirst. The difficulty was overcome in part by carrying kegs of water on wagons, in some organizations, but this primitive arrangement did not fully meet requirements. Troops in the

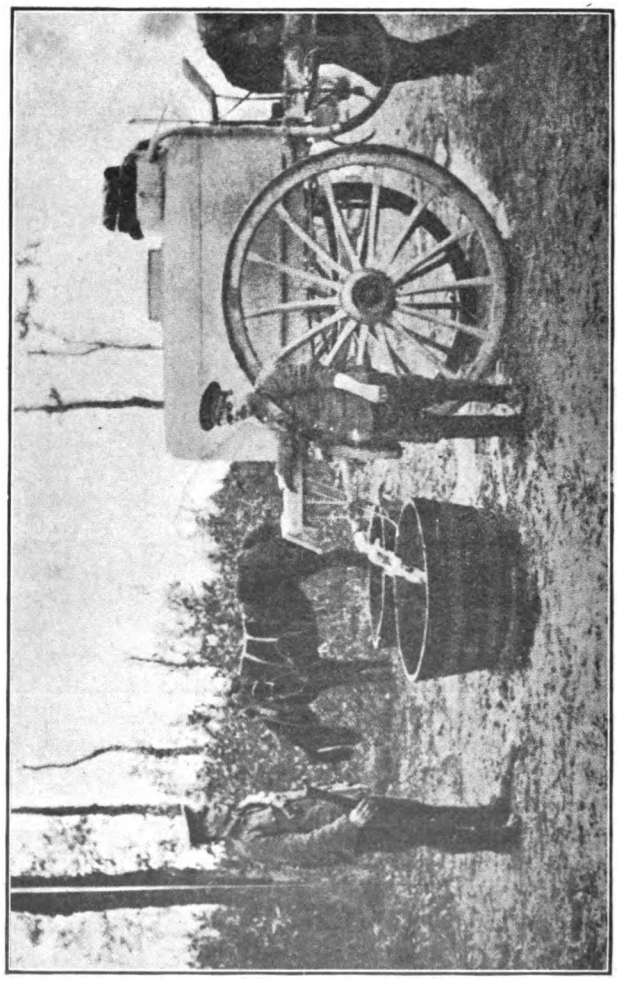

FIG. 116.—Water cart of the British Army delivering a supply to troops at the front. The water containers are habitually under guard by a sentry to prevent waste and contamination. (*Lyster.*)

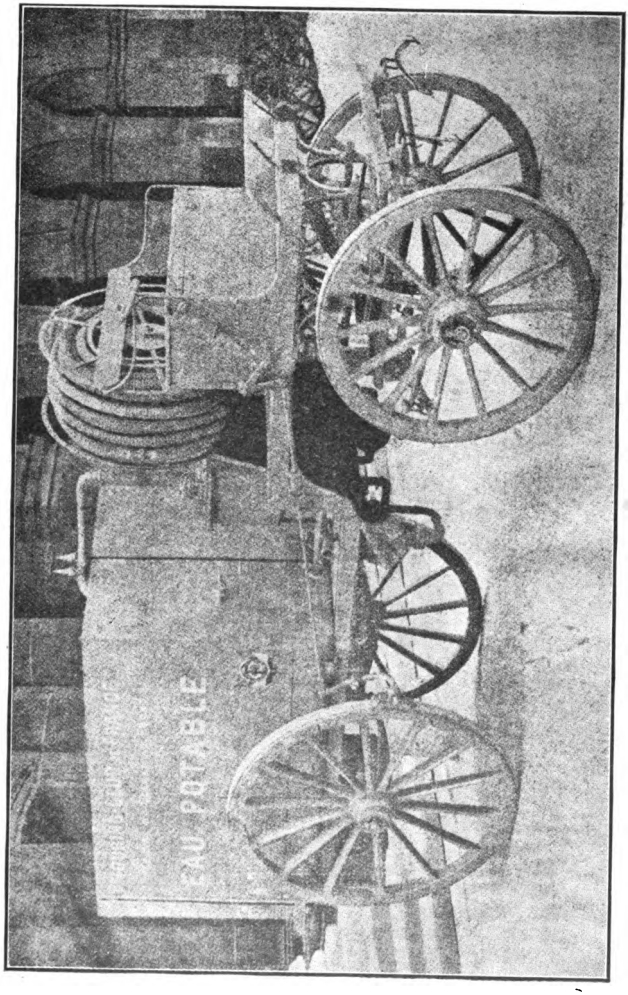

FIG. 117.—A water wagon, French. (*Lyster.*)

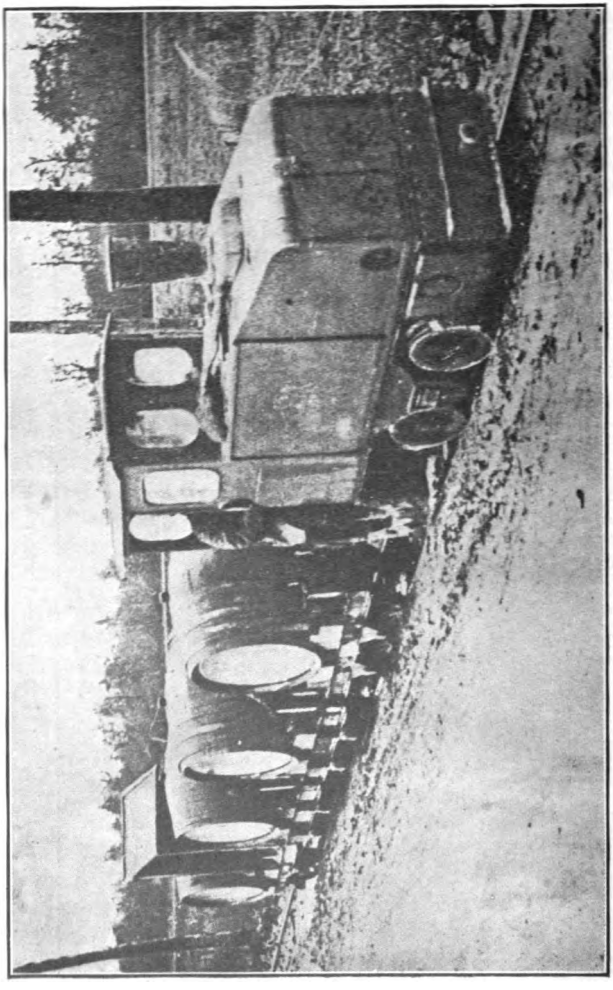

FIG. 118.—Water train on the French field railways used to carry pure water to the troops in the trenches. (*Lyster.*)

trenches are supplied with water from tanks set up about 1,000 yards from the firing line. These are filled by piping, or by horse-drawn water carts. The water is purified by adding 2 grams of bleaching powder to the contents of the average water cart, viz., 110 gallons. From the tanks the water is carried in kerosene tins through the communicating trenches to a dug-out in the support trench, *i.e.*, the second line trench, where it is stored as a reserve for the troops in front. At this point the men in the trenches fill their canteens.

CHAPTER VI

THE MESSING OF TROOPS

A duty of maximum importance is the proper subsistence of the troops,—the unit or detachment commander must see that the food provided is sufficient and properly prepared. The value of food when served, depends upon the ability of the system to appropriate it to the needs of the body, and the 5000 or more heat units stored up in the ration, when chemically analyzed, quickly dwindle below the 3500 which are necessary for the laboring man, when the ration is damaged in transit, wasted by the cooks, or is so poorly prepared that much is thrown away as unfit to eat or if eaten proves indigestible and therefore unnutritious. Much information of proven value for the preparation of food in the field is found in "The Manual for Army Cooks" published by the War Department, "The Mess Officers Assistant" and "The Mess Sergeant's Handbook" by Holbrook. These books are obtainable from the Book Department of the Army Schools, Fort Leavenworth, Kansas.

"Preparation of food, or proper cooking, has much to do with the nutritive value. Cooking changes food into more soluble forms and renders it more nutritious and appetizing. The application of the heat necessary for cooking destroys most disease germs, parasites, and dangerous organisms that the food may contain. This applies to both animal and vegetable food. The cooking of meat brings out the flavor and odor of the extractives and softens the gelatinoids of the connective tissues, making the meat more tender. Extreme heat, however, has a tendency to harden the lean portions (albumimoids) and decrease the flavor. Meats lose much weight in cooking, mainly through the loss of water. The nutritive value of beef soup depends upon the substances dissolved by the water out of the meat, bones, and gristle.

In many vegetables the valuable portions (carbohydrates) are contained in tiny cells with thick walls on which the digestive juices have little effect. The heat of cooking ruptures these walls and

makes the starch more soluble. The heat tends also to produce agreeable flavors by changing the starch into sugar. Flour is made more palatable in the form of bread, cake, and pastry through the use of compressed air, yeast, or baking powder." (Manual for Army Cooks.)

The losses incurred by disease are greatly reduced if the troops be well nourished and this can be secured only by intelligent supervision of the mess and due regard to camp sanitation. The efficiency of any organization commander may be measured as much by the intelligent supervision he gives to the messing of his company as by any other standard. Well-fed troops are in better physical condition than others who are not so carefully looked after; their nervous systems are in better shape, they are more contented and vigorous, they respond cheerfully to the demands made upon them. No better returns are made to an officer than that which comes from the care and attention bestowed upon the mess. Generally speaking the essentials to a successful mess are: An interested commanding officer, an efficient mess sergeant, good cooks, suitable equipment. The organization commander must study the ration and its possibilities, developing himself by observation, experiment and supervision. No part of his duties is so easily mastered and yet so generally neglected.

He should first learn what constitutes the ration and actually make a drawing of it from the Supply Department, in order that he may see it in bulk and appreciate just what there is to work with. The ration is based upon actual requirements developed by many years experience and generally speaking is sufficient. The mess officer's daily inspection of the kitchen too frequently consists of a nine or ten o'clock visit in which the cleanliness and general appearance only are taken into consideration. Although this inspection is necessary, it is more important to be present at meal time to note the service as well as the quantity and quality of the food served. The officer in charge is not expected to usurp the duties of the mess sergeant, whose efficiency is generally over estimated, but it may be necessary for him to prepare the bills of fare himself, and if he does not do this himself to carefully study them at his morning inspection. They should be complete, a constant variety provided, and the food articles should constitute a well-balanced meal. He

should taste the food and express his approval or disapproval of the manner in which the food has been prepared, paying special attention to the seasoning. He should frequently remain in the kitchen during the service of a meal and satisfy himself that the quantities and proportions of food are properly served. His mere presence promotes efficiency. He should inspect garbage cans daily.

The following details are important: Cooks, if unfamiliar with the ration, should not be allowed to use more than the allowance for the day. If they do so, food will be wasted and the command go hungry before the expiration of the ration period. Perishable articles must be carefully preserved; frequently they must be consumed before others to prevent deterioration or loss. Unnecessary waste must be prevented by the careful preparation and service of suitable quantities of food.

Potatoes must be peeled thin or not at all, and the bread served in thin slices or in small quantities as desired. Untouched food left over from each meal must not be thrown away but should be carefully preserved and used in the preparation of palatable dishes for a subsequent meal.

Mess waste is usually due to waste by the cooks or by the men, or to ignorance or dishonesty of the mess sergeant. Cooks waste food by improper preparation, in which event the food is spoiled and must be thrown away; by cooking too large a quantity, so that what is left spoils before it can be used or by throwing away food left over in serving dishes because of wasteful habits or laziness. They do not care to bother with the preparation in appetizing form of left overs. Inspection of garbage can or incinerator daily will sometimes show gross waste of good wholesome food. Waste by men in the troop frequently occurs when they are permitted to help themselves, for they will help themselves liberally and once taken by a man on his mess-kit, food is never used again The simple way to avoid this waste is to have one man serve each component of the meal in succession, in reasonable quantities. Then if a soldier wants more he can come back for it. Dishonesty on the part of the mess sergeant can be controlled only by vigilance, examination of all records and supplies and price. An honest mess sergeant may easily, through ignorance, run his mess into debt through injudicious buying of too great a quantity of perishable

supplies, ill considered storage or ill considered issues. Places for storing rations should be carefully selected. Kitchen cleanliness comprises that of cooks and equipments. Cooks who are personally neat and clean almost invariably have clean kitchens. They should be required to keep the face and hands clean and the face shaved. The kitchen equipment should be clean. This does not necessarily mean polished but it does mean sanitary. Vessels and utensils should be cleaned after every time of use. Especial attention at inspection should be given to the meat grinder, the meat saw, the tines of forks and point where a knife blade joins the handle, dish towels, etc. In garrison or in fixed camp there should be purchased a few serving dishes, gravy bowls, syrup pitchers, etc. Ordinarily men should be detailed to serve as waiters, but in the presence of an epidemic of disease affecting the gastro-intestinal tract, only those men free from disease should assist in either kitchen or mess hall in handling the food.

In such cases there should be a permanent detail of healthy men. Proper seasoning of all dishes is of prime importance. Soups are cheap and palatable food when properly prepared. In fixed camps men should present clean hands and faces and wear a coat or olive drab shirt at meal time.

A ration is the allowance for subsistence of one man for one day. There are five rations used in the army, viz., the garrison ration used in garrison and in permanent or maneuver camps; the travel ration for troops traveling otherwise than by marching and separated from cooking facilities; the reserve ration carried on the persons of the men and in the supply trains and which constitutes the reserve for field service; the field ration prescribed, in orders by the commander of the field forces; and the emergency ration, as the name implies, for use in emergency and to be used only on authority of an officer or in an extremity. The Filipino ration is also provided for native troops. Components of these rations are given, with substitutes, in the Army Regulations, except the field ration which is prescribed by the commander of the field forces varying according to circumstances. It may consist of the whole garrison ration or it may consist only of the reserve ration (bacon, hard bread, coffee, sugar and salt) or it may include such portion of the garrison ration as in the judgment of the commander is necessary. The food ar-

ticles of the reserve ration may be supplemented by food supplies shipped from the rear or grown in the country in which the Army is operating. The only restriction on the commander is that the supplements or substitutes correspond generally with the component articles or substitutive equivalents of the garrison ration.

A ration goes to the organization in one of two forms, either as cash or as food. When the garrison ration is designated the cash allowance of the organization, which is the sum of the cash value of the individual rations of all the men in the organization, for the ration period (which we will assume is a month) is credited to the company, on the first of the month. The company then orders, throughout the month, whatever food it wishes to buy from the commissary. If at the end of the month the company purchases amount to less than the ration allowance, the balance is paid to the company in cash by the Quartermaster. If however, the company purchases amount to more than the ration allowance, the company must pay in cash for what it has overdrawn and if there be no fund the company commander must pay it out of his own pocket. When the field ration or the reserve ration or the travel ration is prescribed, the quantities of food representing the total of all rations to which the organization is entitled are issued to the troop commander, and it is his duty to see that these rations are made to last for the allotted period of time.

A most important item is the achievement of a balanced ration. This is one that supplies proper nourishment to the body without waste excess. The principal food ingredients are protein, fat, carbohydrates, mineral matter and water.

The chief uses of food are three: (1) To form the material of the body and repair body waste. (2) To furnish muscular power and energy for the work that the body has to do. (3) To yield heat and thus keep the body warm. A well balanced ration is one that provides proteins, fats, carobhydrates, mineral matter and water in the proper relative proportions. That is, it should contain enough protein to repair the body waste caused by the labor performed, enough fat and carbohydrates to maintain body warmth and yield energy in the form of heat and muscular power; enough mineral matter to share in forming bone and assist in digestion. Protein occurs most abundantly in animal foods, meats, fish, eggs and dairy

products and in the dried legumes, as beans and peas. Butter and lard are exceptions to this statement as they represent the fat of milk and meat. Protein in meats varies from 14 to 26 per cent. of the edible portion. It forms 28 to 38 per cent. of cheese and 18 to 25 per cent. of dried beans and peas. It makes up 7 to 15 per cent. of the cereals, being least abundant in rye and most abundant in oats. Wheat flour contains from 9 to 15 per cent. of protein. Fresh vegetables contain practically none at all.

Infected meats may transmit a number of infectious diseases, *e.g.*, tuberculosis, typhoid fever, anthrax, ray fungus and certain ailments caused by bacteria which occasion disease in animals and may cause sickness in man, *e.g.*, milk sickness. Also they may transmit tapeworm (especially beef, fish and pork), and trichina (by pork). Ptomaine poisoning follows infection of meat that occurs after butchering and either before or after cooking. The process of cooking does not destroy the toxins that the bacteria causing this disease develop. Meats are preserved by freezing (which will not destroy all parasites) or by salting, packing, curing or smoking. But the prolonged ingestion of meats thus preserved impairs digestion. Cans whose ends bulge should be rejected.

Protein is less readily absorbed from vegetables than it is from meat.

Fats generate heat and warmth; they are found abundantly in meat, butter, olives, oatmeal, corn and nuts. They have great fuél value in small bulk, but an excess is difficult to digest. Men can live in excellent health on meat and fat alone. The amount of fat in the body varies greatly with food, exercise, age and other conditions. When more food is consumed than is necessary for immediate use, part of the surplus is stored in the body. The protein and fat of food thus becomes body protein and body fat. When the food supply is short this reserve material is drawn upon for supplementary fuel.

The chief source of fat are the animal foods, though some fat is derived from vegetables the most noteworthy of which in this respect is corn. Oatmeal contains about 7 per cent. The quantities in meat vary from 10 per cent. in beef tenderloin to 80 per cent. in fat salt pork. Milk averages about 4 per cent. of fat, butter is nearly pure fat and whole milk cheese (or so called cream cheese) contains

from 25 to 40 per cent. of fat. Most cheeses are about one-third protein and one-third fat and are therefore highly concentrated foods. Both milk and cheese may develop poisonous toxins through bacteria present, *e.g.*, tyrotoxicon. Also milk may transmit a number of diseases, *e.g.*, tuberculosis, typhoid, and paratyphoid fevers, dysentery, diphtheria and scarlet fever. With the exception of oatmeal which contains about 7 per cent., there is but little fat in cereals or in legumes. In green vegetables and fruits it is almost wanting.

Carbohydrates include starches, sugar and fibre of plants. They are found chiefly in vegetable foods, *e.g.*, potatoes and grains. They are the source of body energy and may be converted into fat but the two are not interchangeable as they have different functions to perform. Their fuel value, weight for weight, is about that of proteids, but less than that of fats. They may be taken in large amounts.

The carbohydrates, are almost entirely absent from animal foods, but form the most important element of vegetable foods. They make up from 65 to 75 per cent. of the cereals, 60 to 70 per cent. of the dried legumes, and the bulk of the nutrients of fresh vegetables and fruits. The most important forms in which carbohydrates occur are wheat and vegetables. An excellent quality of bread is prepared in field bakeries. The formation of "rope" can be prevented by adding 1 quart of vinegar to each 100 lbs. of flour, if the bakery becomes infected. Cornmeal bread is nutritious, palatable and relatively cheap. Raw fruits and vegetables should be well cleaned before eating. The heat of cooking is usually sufficient to kill all infectious organisms.

Together with the food ingredients should be noted inorganic salts, water and vitamines, which are essential to health. Vitamines exist in foods in very minute quantities, but their absence may give rise to several diseases, *e.g.*, scurvy, beri-beri, and possibly pellagra and rickets. Also organic acids are essential to health. Condiments and spices are of great culinary value as they improve flavors and thus promote digestion. Cooks should have a good knowledge of seasoning.

No articles of food contain these different nutritive constituents in proper proportions. Some foods are too rich in proteids;

others contain too much carbohydrates and fat. The former statement applies to all animal food and to such vegetables as dried peas, beans and lentils, etc. Most other foods, however, contain an excess of starchy matter.

A proper ration must be a mixed one, the excess of a particular element in one article being offset by its deficiency in another. This conclusion is the result, not only of scientific investigation, but of practical experience. Hence the popularity of such combinations as bread and butter in which the proteids and carbohydrates of the bread are supplemented by the fat of the butter; beans and bacon, wherein the proteid and carbohydrates of the beans are balanced by the proteid and fat, principally fat, of the bacon; potatoes and beef, in which the carbohydrate of the potatoes is complemented by the proteid and fat of the beef. It is not possible to prescribe a hard and fast diet that would perfectly meet the requirements of all individuals for they perform different duties and have different idiosyncrasies. The diet is selected to meet average requirements. Nothing better than the Army Ration has as yet been devised. About 11 per cent. of it is proteid, about 10 per cent. fat, about 46 per cent. carbohydrate, the remainder being water, mineral matter, ash and refuse. The ration is ample in garrison but seems to fall slightly below what is necessary in active field service. This is largely due to the impossibility of carrying along or caring for left-over food which, in consequence, must be thrown away. This can be met only by careful supervision of quantities and equivalents used. It is not necessary or desirable that the company commander limit himself to the particular articles enumerated in the ration. Substitutes are provided for, and to give variety should be used. For beef, can be substituted mutton, veal, pork, game, fowl, fish, liver, beef hearts, sweetbreads, ham-butts, eggs or sausage; for potatoes, carrots, turnips, salsify, sweet potatoes, pumpkins, green peas and beans; for dried fruits, fresh fruits when available, for coffee, hot or cold tea and cocoa; for dried beans, dried or split peas, lima beans or lentils. All such substitutions may be made without materially affecting the almost perfect balance of the ration or markedly increasing the cost.

In handling the ration, the savings made on one component of the ration may be used for the purchase of similar articles not found

in the ration table. For instance, if the 18 ounces of bread, per man per day, on which the ration allowance is based, are not purchasad from the commissary the fund saved may be used to purchase oatmeal, etc. With the savings on coffee one can purchase tea and cocoa. The principal savings should be made on the bread and meat allowance. Meat savings are made by purchasing a variety of meats from the packing house, the tendency being to purchase those of less value than beef. In this way the meat diet is varied, a considerable saving in money is made and the men are issued a variety of food articles not otherwise obtainable. For instance when the cost of beef was 11.29 cents per pound, in the fiscal year 1915–1916, we could buy numerous substitutes and make a saving on each. The quantity of bone, cartilage and inedible parts in beef is about one-fifth of the carcass weight and computations are usually based on this amount. In veal and light weight cattle it is greater. If one-fifth is added, the price of the edible part of the beef will be 13.55 cents per pound. If we can, therefore, purchase meat or meat products with no inedible or refuse portions, we may pay about one-fifth more for it than the value of the article replaced and not lose. This fact enlarges the list of outside purchases thus insuring a still greater variety. It has been found from experience that if messes expect to subsist the men on the ration allowance, nothing should be permitted to go to waste. Especially is this true in the case of food left over from previous meals. All such left-overs should be used up in the next twenty-four hours. Potatoes left over should be used in meat balls, hashes, potato cakes, croquettes, and hash; corn in corn chowder; tomatoes in tomato and macaroni soup; beans and peas in soup or in salad with celery and lettuce. From left-over bread can be made croutons, cutting the bread into small cubes and toasting in the oven. It is used in bread pudding, plum duff, bread dressings, or put in the oven, toasted crisp and then run through a meat grinder, the crumbs resulting therefrom being used for breading beef steak, fish, meat balls and croquettes. These crumbs may also be used as pie filler and in the preparation of batter cakes, muffins, etc. Such things are all inexpensive.

Capt. Bach summarizes certain points as follows:

1. Look in your garbage cans and incinerator *daily* to see if good food or thick potato peelings are in them.

2. Be present at at least two of the meals of your company to see how the food is served and that the men take no more on their plates than they can eat. Taste the food yourself.

3. Carefully check once each week the standing of the mess as to its financial condition.

4. Have your mess sergeant (after consultation with the cook) prepare a bill of fare for the ensuing day, check this and see that balanced meals are provided. See that the cooks prepare the articles shown on the bill of fare.

5. Look through ice boxes or refrigerators, see that they are clean and that left-over foods are properly cared for.

6. Insist that meat be boned before it is cooked; that the bones be put in the stock boiler for at least twelve hours before being burned in the incinerator. This stock can be used for soups, gravies, etc.

7. Have potatoes sorted as soon as received from the commissary and rotten ones thrown out.

8. See that the bread served is cut in small pieces. This will save you at least 25 per cent. of your bread cost. Let the men come back for more if they want it.

9. Do not let the cooks throw away good food. Utilize left overs.

Bills of fare for one week illustrative of a balanced and palatable ration are given on pages 43–46 of the "Manual for Army Cooks."

A sick animal has hair that is rough, staring and dingy; the muzzle is hot and dry, eyes are congested and watery. It has accelerated pulse and respiration, and ruminates irregularly. Animals below the following minimum weight should not be accepted: beef, 550 lb., cows, 365, calves, (1 month) 150, sheep, 48.

The butchered animal's viscera should be inspected. The following are the characteristics of healthy beef which has been cut at least an hour (fresh meat is always dark): bright, clear, cherry red color, marbled with fat; it is firm and elastic, but to the touch is soft and very smooth. It should not pit nor crackle on pressure. It should exude a bright red juice. A purple color indicates that the animal has died of disease; a pale, moist appearance that the animal was very young and sickly, a dark, stringy appearance that it was old. The fat should be reasonably plentiful, firm in consist-

ence and oily to the touch. The cellular tissue should be very white, without infiltration, and without exudation of fluid when cut. The odor of the meat should be fresh and not disagreeable. The marrow of the long bones of the hind legs is firm with a light pink color, that of the fore legs is yellowish, with the consistence of honey. The pleuræ are glossy, transparent, glistening. The arteries contain no blood. The lymphatic glands are of normal size, of an amber color on section. The cut surface is glossy and regular, and allows but a small quantity of fluid to exude.

Poor meat is flabby, pale, thin, of a washed-out color, blood stained or spotted, or even mahogany; frequently infiltrated with bloody infiltration; not infrequently it has a greenish tinge, sometimes in spots only. The odor is stale, sometimes acid or fœtid, as if it had been treated with chemicals. At times the surface has a spoiled appearance. Decomposition always begins in certain limited areas. To test the full volume of the meat, plunge a knife in to the bone, through a cut made in the surface. The knife should not touch the edges of the superficial cut. If the knife can be withdrawn without resistance of the tissues, it indicates that the meat has begun to decay. Also the odor of the knife on withdrawal will indicate the condition of the deeper parts of the meat. If only the superficial part is affected, this should be cut away, and the remainder used.

In old animals the fibres of the meat are long, thin and dry; in very young ones they are soft, pale, spongy, or if the animal be very young, gelatinous. The fibrous tissue in spoiled meat is of a dirty white color and infiltrated, the marrow is more or less fluid, sometimes brownish and does not fill the osseous canal. Fat is scant, pale, injected, scarcely oily to the touch and appears like coagulated oil. In some undesirable carcasses the glands are enlarged, injected, suppurating or caseous. The vertebro-costal glands, the intercostal glands near the sternum, in the 3″, 4″ and 5″ interspaces, the large gland near the shoulder blade and the retro-pharyngeal and maxillary glands especially are liable to be affected in diseased animals.

Of the total weight of an ox, from 50 per cent. to 54 per cent. should be meat; of a cow 46 per cent. to 54 per cent. (being greater in young animals), of a calf 60 per cent., of a sheep 50 per cent. To

calculate the weight that should be available add four-sevenths of the total weight to the total weight itself, and divide by three. To determine the number of rations that an animal would furnish, divide the weight on the hoof in pounds, by two and one-fifth, *i.e.*, each kilogram of the living animal represents one ration. The weight of cooked meat is generally 35 to 38 per cent.

Meat should be distributed by auto trucks provided with suspension apparatus and hooks. These trucks should be ventilated through screened openings. If suspended transport is not available, the floor of the vehicle should be covered with a clean cloth and contact between the sides of beef avoided by placing straw between them. Compression is an important element in accelerating the decomposition of food. These vehicles should be ventilated as above noted. Meat cloths should be washed after each usage and the wagon cleaned with sodium carbonate solution. No other supplies should be transported with meat as it rapidly assumes their odors. Changing meat from one wagon to another should be done as seldom as possible. If possible this should be done in the shade. Meat should be cooked within 48 hours at most after removal from refrigeration. If delivery of the meat is delayed and there is no occasion for its immediate service, it should be cut into small pieces and boiled ten minutes, after which it is removed, salted and suspended in a sack—not kept in a closed vessel.

In warm weather, quarters of beef, when received by organizations, sometimes appear to be tainted. The outside of the meat is wet and rather slimy and the odor is that of spoiled meat. Frequently however all that is necessary is to remove the disagreeable odor. The meat itself may be perfectly sound. The odor can be removed by washing the outside of the meat with a solution consisting of 1 gallon water, 1 pound salt, 1 pint vinegar and 2 tablespoonfuls of baking soda. If, after washing thoroughly with this solution, the meat is fresh and sweet it may be used with perfect safety.

CHAPTER VII

CAMP DISEASES

Transmissible diseases, *i.e.*, those caused by parasites or micro-organisms are the most common causes of morbidity in the military service. The infections most frequently encountered (including especially those which occur in epidemics) are peculiar to the human race, *e.g.*, typhoid fever, mumps, measles; but others also occur which may develop in both men and animals, more frequently in the former, *e.g.*, tuberculosis. Yet others are common to man and to insects in which the disease germs undergo different developmental stages, *e.g.*, malaria; while some are contracted from animals, *e.g.*, hydrophobia, malta fever and anthrax. Frequently diseases are transmitted by insects which act merely as mechanical agents, and in which the germ undergoes no developmental process, *e.g.*, plague is thus transmitted by the flea and typhoid fever by the fly.

The causes of infectious diseases are predisposing and direct. Predisposing causes (*i.e.*, susceptibility), are inherited or acquired. Acquired susceptibility is usually commensurate with some depression of vitality. This may be brought about through a lowering of vital resistance by:

1. Exhaustion, physical or mental, especially if associated with anxiety or worry, and with insufficient sleep, rest or recreation.
2. Previous infection with a disease, *e.g.*, pneumonia, susceptibility to which is thereafter increased.
3. Malnutrition from inadequate food or digestive disease.
4. Over feeding, leading to retention of poisonous wastes.
5. Faulty ventilation and overheating of rooms.
6. Alcoholism and vicious habits.
7. Exposure to cold, and
8 Uncongenial climate.

Many persons harbor parasites whose activity remains latent until the host's vitality is depressed. The direct causes of infectious

disease are living, minute unicellular micro-organisms which belong to the lowest orders of the vegetable and animal worlds.

Bacteria.—Such vegetable organisms (bacteria) abound throughout nature. They are classified according to several standards:

1. Disease-causing qualities; those causing disease are pathogenic, others are non-pathogenic.

2. Environment; those that live in the tissues of animals or plants are parasites; those that live in dead organic matter, the soil, air or water, are saprophytes. The line of separation between these two classes, however, is not clearly drawn or fixed, as some species develop under both conditions, *e.g.*, the bacillus Welchii, which lives in the soil and causes gas gangrene in man. However most bacteria which cause disease do not live long outside the body. Saprophytes are vastly more numerous than parasites. Their activities in nature are beneficial to the human race, since they split up animal and vegetable refuse into simpler chemical bodies, which can be assimilated by plants. Also, through their activities they destroy the parasitic bacteria with which they come in contact. They thus make vegetation possible, and in turn the animal life which is supported by it.

3. Shape; cocci are spherical bacteria, bacilli are straight rods from two to ten times as long as wide, and spirilla are curved. Most bacteria measure about one twenty-five thousandth of an inch in their shortest diameter.

4. Obtainment of oxygen; all bacteria require oxygen. Aerobes are those that obtain it from the air, anaerobes from carbohydrates, easily oxidized bodies, etc. Those which obtain it from either source are facultative. For their growth, bacteria require food, moisture and a suitable temperature. There is a certain optimum temperature at which each species grows best, that for pathogenic bacteria being as a rule that of the human body. Bacteria multiply by splitting transversely after they have reached a certain size. If the environment is favorable, they grow and reproduce rapidly, obtaining mature size in from twenty to thirty minutes and one parent cell may produce one million descendants in ten hours. Under unfavorable conditions some varieties produce spores which will resist injurious influences, but, when favorable conditions recur, will develop into the mature parasites.

Certain varieties of bacilli and spirilla have hair-like appendages or flagellæ, by means of which they are actively motile. Pathogenic bacteria are destroyed or their development is retarded by direct sunlight, drying, unfavorable temperature, and various chemical agents. The degree of heat or cold necessary to destroy bacteria varies greatly. Most non-spore-bearing varieties are killed by steam in a few moments, but many varieties can withstand dry heat at two hundred and twelve degrees for an hour. The chemicals which are most used to destroy bacteria, are phenol (*i.e.*, carbolic acid), chlorinated lime, mercuric chloride, formaldehyde, sulphur dioxide and potassium cyanide.

Protozoa are unicellular micro-organisms belonging to the animal world. Like bacteria, some varieties are parasitic; others are saprophytic. Also they are pathogenic or non-pathogenic. Their structure is more complex than is that of bacteria, and they cannot exist on such simple foods outside the body. Some of these pathogenic protozoa, *e.g.*, those causing yellow fever, are too small to be seen through the microscope. The life cycle of many pathogenic protozoa is more complicated than is that of bacteria. Some require two hosts for their development, *e.g.*, those causing malaria which develop different stages of their life cycles in man and in the mosquito. The most common diseases caused by protozoa are malaria, yellow fever, dengue, elephantiasis, sleeping sickness, entamebic dysentery and syphilis.

Infection.—Infection with a specific disease may be brought about in three ways:

1. Direct contact, which may be immediate or mediate.
2. Indirect contact.
3. Through an alternative host.

Contact infection is that which occurs from a diseased person, either from direct personal contact with that person himself (immediate contact), or with some article which the patient has infected (mediate contact). Immediate contact infection may occur through shaking hands, etc. Mediate contact infection may follow the use of some article which the infected person has used, *e.g.*, handkerchiefs, toilet articles, pipes, mess articles, rifle, etc. This mediate transmission occurs as a rule within a few hours after the object was infected. Most parasites are frail and die after exposure of

but a few days to indirect light or air. Infection by immediate or mediate contact, *i.e.*, by carriers, is the commonest way in which diseases are spread. This is especially true in the military service where contact is close, frequent and intimate.

Carriers.—Carriers comprise : 1. Those who have had a disease and continue to excrete the parasite causing it, by discharges from the nose and mouth, in the urine or in the feces.

2. Those who give no history of a given disease, *e.g.*, typhoid, pneumonia, diphtheria, etc., but who harbor the parasites causing it. Though the germs may have given rise to no symptoms in the carrier, they may, when transferred to another person, cause an acute infection because of his greater susceptibility. An important class of carriers are the missed cases, who have the disease in so mild a form that it escapes detection, but who nevertheless may cause a most virulent infection in those to whom they transmit it. They are especially dangerous to their associates, since they continue to mingle with them as freely as when they are well. Carriers may be acute, chronic or temporary. The first discharges parasites for a few weeks after an attack of the disease; the second for months or years; the third are those who have never had the disease, but who harbor and discharge the parasites for a brief space of time. This discharge of parasites may be intermittent. For this reason, a typhoid fever patient in our army is not returned to duty until three successive weekly examinations of stools have been negative.

The manner in which some infections are spread is not yet fully understood. In the camp at Dublan, Mexico, an epidemic of pneumonia occurred, but only two patients came from the same tent. Similarly epidemic cerebrospinal meningitis occurred in the camp around El Paso, no two cases appearing in the same company. Over four hundred cases of pneumonia were admitted to the Base Hospital at Fort Bliss, in the eight months ending March 31, but in only three instances did two of these cases develop in the same tent.

Indirect Infection.—Indirect infection occurs through water, food, air or the earth. The infectious diseases transmitted by water are most commonly certain types of diarrhea, dysentery, typhoid and paratyphoid fevers and cholera.

Water.—Diarrhea may be caused by the following micro-organisms

in water, viz., b. coli, b. enteritidis, b. pyocyaneus, b. proteus, b. aerogenes capsulatus or b. mesentericus. Typhoid, paratyphoid fevers and cholera may be caused by infected water. Both bacillary and entamebic dysentery may be transmitted by drinking water, though but few epidemics of water-borne dysentery have been reported, and entamebic dysentery does not always occur in epidemic form. The commonest varieties of bacilli causing dysentery are the Shiga or Flexner strains, but numerous other strains have been incriminated. The entameba histolytica is the only rhizopod known to cause dysentery, but a very similar, comparatively rare disease, is caused by the a ciliated protozoon, the balantidium coli. All diseases caused by drinking water affect primarily the alimentary tract. Water may also convey the eggs, larvæ or other stages in the life cycle of various intestinal parasites, *e.g.*, the round worm (ascaris lumbricoides), pin worm (oxyuris vermicularis), whip worm (trichuris trichiura), bilharzia hæmatobia and, in some cases, those of the guinea worm (dracunculus medinensis), and the hook worm (ankylostomum duodenalis and necator americanus).

Food.—Food is frequently an agent in transmission of disease. Milk is an excellent culture medium for many pathogenic germs and has been responsible for numerous epidemics of typhoid fever, Malta fever, scarlet fever, diphtheria and epidemic sore throat. If drawn from tuberculous animals it may cause tuberculosis. Vegetables grown in earth enriched with the night soil may transmit cholera, typhoid fever and dysentery. The meats most commonly causing disease are pork, which may be infested with trichina, and shell fish which may have been infected with germs of typhoid fever or dysentery. Ptomaine poisoning follows the use of food which has been infected by any one of several varieties of bacteria, especially the bacillus enteriditis, but properly speaking, it is not an infectious disease. It is caused by the products which the bacteria have formed in the food before and after ingestion, and not by the invasion of the parasites into the body, *i.e.*, these bacteria affect food primarily and the body secondarily.

Soil.—Through its products, soil may be an agent in the transmission of infections because of the contamination which it may undergo whether by man or animal. Though most disease germs excreted by man die in a few days, some survive for a longer period. Certain bacteria which animals pass may live in the soil indefinitely, *e.g.*,

those causing tetanus and anthrax; others normally exist in the soil, *e.g.*, b. œdematis maligni. The tetanus bacillus is often found in the excrement of horses and cattle, and is common in the soil of warm countries. Anthrax bacilli may multiply in the soil and earthworms may bring its spores to the surface from buried carcasses through five feet of earth. Several other species that are pathogenic to man also multiply in the earth. In the European war tetanus and gas gangrene have been common complications of wounds, for the reason that in trench warfare, men's clothing and skin have been fouled with earth, and germs, and these have been carried into the wounds.

Air.—Air may transmit germs as these minute creatures are practically always attached to particles of dust and to droplets of fluid expelled from the nose or mouth. Since pathogenic bacteria are soon destroyed by air and sunlight, dust is a means of transmission only under exceptional circumstances. Though bacteria are not found as a rule in expired air, infected material may be propelled into the air several feet in droplets, whether by speaking, sneezing, coughing, etc., so that a carrier may thus be a menace to his companions. People living in close contact, as in crowded and unventilated rooms, tents, etc., are especially exposed to infection in this manner. The diseases most commonly transmitted by droplets are measles, scarlet fever, influenza, diphtheria, tonsillitis, pneumonia and poliomyelitis.

Insects.—Certain diseases can be transmitted from man to man only through an alternative insect host, in whose bodies the parasites develop a different phase of their respective life cycles. Such diseases are malaria, yellow fever, dengue and elephantiasis, transmitted by mosquitoes. Rocky mountain spotted fever, Texas fever and West African relapsing fever are transmitted by ticks. It is yet undecided whether the parasites causing some diseases, *e.g.*, typhus, may not undergo certain changes in the body of the insect transmitting them, so that these are in fact alternative hosts and not mere mechanical agents in transmission. Transmission by an insect host in which the germ undergoes a distinct life cycle is called biological in contrast to mechanical transmission, in which certain insects act merely as carriers of parasites from one person to another, and in whose bodies no separate life cycle occurs. Mechanical transmission by insects has been responsible for numerous epidemics, *e.g.*, plague is thus

transmitted by the flea; paratyphoid, typhoid, dysentery, (both bacillary and entamebic), cholera, tuberculosis, glanders, contagious ophthalmia, small pox and other exanthemata and skin infections, erysipelas, etc., by the fly; European relapsing fever and perhaps typhoid fever and plague by the bed bug; typhus fever by the head louse, much more frequently by the body louse and probably by the crab louse and possibly by the bed bug. Probably Asiatic and Algerian relapsing fever are transmitted by lice.

Infection by parasites may occur through the skin or the respiratory, digestive, or genito-urinary systems. Since parasites are numerous on the skin and clothing, they are frequently carried into wounds where they may give rise to local or general infections. They may penetrate into the air follicles and sweat glands, causing boils and carbuncles. They may be introduced by the bites of insects or rubbed into a bite caused by an insect carrying germs. The nose and upper air passages are the avenues of infection in diphtheria, measles, scarlet fever, epidemic sore throat, etc. Through the alimentary tract enter the germs of typhoid fever, dysentery, etc. The tonsils are the port of entry of several general infections, *e.g.*, rheumatism. The greatest number of infections occur through the nose and mouth. Venereal diseases are the most common infections occurring through the genito-urinary tract.

Conditions of Infection.—Infection occurs only when four essential conditions exist, viz., the host must be susceptible, the invading parasites must have sufficient virulence, their numbers must be adequate, and they must enter by appropriate channels. Susceptibility varies between individuals of the same race, and in the same individual from time to time, for reasons mentioned above. Similarly, different species of parasites vary greatly in their relative virulence, and in a given species certain strains of individuals are much more virulent than others. Virulence is increased by the passage of the parasites through successive hosts favorable to their reception, a fact which explains why the virulence of infection increases as an epidemic develops. The parasites must be numerous enough to overcome the power of resistance which the body is able to offer. A certain number of parasites may not be able to cause infection which a larger number of the same strain and virulence would effect. In this respect their activity is comparable to a military attack, large

numbers succeed where small numbers fail. The channel through which infection occurs must be suitable. The germs of cholera cause no abdominal symptoms when injected under the skin; they must enter by the mouth. Gonococci do not set up infections in the alimentary or respiratory tracts but only in the genito-urinary tract or in the eyes.

When parasites give rise to infection they multiply rapidly, and produce poisons known as toxins. The chemical composition of these varies widely. Each variety develops its own type of toxins. They cause the body cells of the host to develop anti-bodies which are antagonistic to the harmful action of the bacteria. The characteristic symptoms of the disease are caused by the poisons which the parasites develop and by the anti-bodies produced by their diffusion. The course of infections presents the following periods or stages: (1) Incubation, which begins at the time of infection and lasts from a few hours to several weeks or months, until the first symptoms appear. It is during this stage that the invading parasites are multiplying in the body. (2) The prodromal period which follows this, presents general, definite, symptoms such as muscular weakness, headache, chills, slight fever, etc., due both to the poisons of the parasites and their effects on the tissues of the body. (3) The period of acute symptoms, which is characterized by the typical symptoms of the disease. It is at this time that the parasites reach the maximum of their activity and toxins and antitoxins are produced in greatest quantity. (4) Periods of decline and convalescence, during which the bacteria are destroyed, and their toxins eliminated. A fatal result ensues when the defences of the body are overcome by the destructive effects of the parasite.

Immunity.—The body possesses several defenses against infection. The first of these is mechanical, and is afforded by the skin and mucous membranes. The second is that afforded by the secretions from the latter, which act, both chemically to destroy parasites, as does the gastric juice, or mechanically, to wash them away. In addition to these there are the defenses which the blood normally possesses or which the body develops when it is invaded. These defenses against infection constitute the condition known as immunity. If parasites enter the body, they may be destroyed by normal blood serum or by the white cells in the blood. If these

fail, the body develops anti-bodies. Some of these destroy the parasites, others render them inert, so that they may be destroyed more readily by the white cells in the blood, and yet others neutralize the bacterial toxins. The essential reasons of immunity are not yet fully understood. The mechanism varies with different infections and at different stages of the same infection.

Immunity may be natural or acquired. The former exists when the parasite is unable to grow in the body, *e.g.*, the immunity of the lower animals to typhoid fever. This form of immunity is hereditary. Acquired immunity is that due to antitoxins which the body produces when invaded—not to substances already present in the blood, as in natural immunity. It is not hereditary. Two forms are recognized, active and passive. The former is produced by the individual as a result of a previous attack of a certain disease, the latter as the result of an artificial inoculation, in order to prevent infection. An example of the former is the immunity following an attack of typhoid fever, the latter, the immunity developed after injections of typhoid prophylactic. The former usually lasts through life, the latter for about 3 years. Passive immunity follows the injection of antitoxins developed by another animal. An illustration is that following the injection of anti-diphtheria serum. This is drawn from a horse which has been immunized by the injection of increasing doses of the diphtheria bacillus.

Disease germs leave the body by the following routes:

1. In the secretions from the nose and mouth, as in tuberculosis, influenza, etc.
2. The discharges from the bowel, as in typhoid fever, cholera and dysentery.
3. The skin, as in boils, syphilis, leprosy.
4. The urinary tract, as in typhoid fever.
5. The blood, by the bites of suctorial insects, as in malaria, typhus and yellow fever.

FILTH DISEASES

Typhoid Fever.—The most important diseases transmitted by dejecta, are typhoid and paratyphoid fevers, dysentery and cholera. These are typical excrement-borne diseases. They are also transmitted by contact, water, food and flies. Epidemics of them are

especially prone to occur in armies, since some of the troops are carriers. Recruits who harbor the parasites, are constantly joining, and the men are so closely associated that contact infection is greatly facilitated. Typhoid fever is the most common filth disease, and was the most formidable infection in the military service before the introduction of specific prophylaxis. It is common in civil life, and was frequently introduced into the army from that source, either through newly enlisted carriers or through recruits joining in the incubation stage of the disease. It is reasonable to assume that of every 1000 recruits 3 are carriers and one or more others in the incubation stage. Its symptoms are often misleading, for they may be similar to those of a simple diarrhea, gastro-enteritis, malaria or a mild malaise, and this fact prevents prompt isolation. The parasite enters the body through the mouth and leaves it in the bowel discharges, urine, and in about one-fourth of the cases in the sweat and sputum. Usually it does not live more than two days outside the body. In fecal matter it lives for two or three days if not exposed to the sun in clean dry soil, and from three to four days in soil polluted with organic matter and saprophytes are present. In water it disappears in from three days to two weeks but may live in ice for months without loss of virulence. It multiplies rapidly in milk without changing taste or appearance, and survives in milk products of which the most dangerous is ice cream. It multiplies in some soft drinks sold by camp followers. The disease is transmitted by contact in probably 60 per cent. of the cases. The transfer sometimes occurs in dry fecal matter or urine on the hands, body or clothing of the carrier or of a patient in the incubation stage. This matter may be transmitted directly, or through the medium of some objects which the carrier has touched. Of the 20,000 cases which developed in the army during the Spanish American war among 107,000 troops in camp, the greatest number were caused by contact. Many patients continue to excrete the bacilli in both feces and urine after convalescence, about 4 per cent. excrete it ten weeks after the end of the fever and 2 or 3 per cent. for a year afterward. Most of these carriers discharge the germ for years and some throughout life. Other carriers, who number about three per thousand of our adults, excrete the bacteria for years or for life, though they give no history of having had the disease,

although probably, at some time they have had a mild attack. The parasites may be discharged intermittently. Those excreted in the feces come from ulcers in the gall-bladder, and those in the urine from ulcers in the urinary bladder. Because of the percentages of carriers and patients in the incubation stage, all dejecta must be considered infective.

Carriers who handle the food supplies are the most serious menace in a company. Flies may carry germs on their feet or proboscides or in their digestive organs from latrines to the kitchen and dining rooms. Contaminated drinking water causes 35 per cent. of the total cases of typhoid fever in civil life. Before the water supply was so carefully selected and purified the percentage was much higher.

For similar reasons water-borne typhoid became less common in fixed camps, before the introduction of prophylactic. The danger of infection by polluted ice becomes less the longer the ice is in storage. At the end of 4 months the danger is almost negligible and at the end of 6 months, quite so.

Food infection is not uncommon. Milk or its products are the most common agents of transmission of this class. Fresh vegetables eaten uncooked, *e.g.*, radishes, lettuce, etc., if grown on polluted ground or washed in polluted water may cause the disease. Oysters or other shell fish grown or washed in polluted water have occasioned small epidemics. Infection of a body of men may follow unconscious contamination of food by a cook who is infected.

Soil infection follows its contamination with urine or feces. The former is especially dangerous as urine is relatively innocuous. From such soil bacteria may be washed into drinking water or scattered by flies and dust.

Prevention of typhoid fever is effected by measures applicable to other infections of the alimentary tract. Water supplies should be protected. If they become contaminated they should be purified. Milk and food products should be supervised carefully and inspected frequently. Food should be protected from contamination by flies, dirt, soiled hands, etc. Cases of typhoid fever should be isolated and regulations enforced covering the disinfection of stools and urine, scalding of milk bottles, scrubbing and washing of hands by attendants, etc. Carriers should not

be permitted to assist in preparation or service of food or employed in vocations where close contact is involved. Personal cleanliness should be enforced among troops. Excreta should be disposed of properly and effectively. Protective inoculation should be practised. This is given immediately after entering the service to all persons except those over 45 years of age and those who have had a previous attack of typhoid fever, or who have been immunized within three years. The fact that either of the last two exemptions is applicable in a given case is determined by the responsible medical officer. He should not accept the statement of the person exempted, unless supported by official records.

Officers under 45 years are immunized every 5 years, and enlisted men on the first enlistment following the original course of administration. Except when directed by the War Department only two complete courses of immunization are required during service in the Army.

"Recruits will be immunized at places of enlistment, unless, because of special assignment or other reason, the men are not to remain at the station long enough to allow the completion of the course, in which event the immunization will be completed immediately after they join the organizations or stations to which assigned. On the descriptive and assignment card of every recruit or reenlisted man will be noted "Typhoid immunization completed . . . (date) . . . " or "Typhoid immunization not administered," as the case may be. In the latter case, company and detachment commanders will see that the immunization is begun immediately after the men join the organizations or stations to which assigned. In every case in which immunization has been completed, the remark "Typhoid immunization completed . . . (date) . . . " will be entered on the soldier's descriptive list.

" Civilian employees who are subject to field service of any kind, including those on transports and in the mine planter service, will be immunized as soon as employed. Officers under whom such employees are working will enforce this order.

" The typhoid prophylactic to be used is manufactured exclusively at the Army Medical School, Washington, D. C., and detailed directions for its use are given in circulars from the Surgeon General's Office. Records will be kept at the hospital, of all officers, soldiers,

and civilians in the military service who receive the anti-typhoid prophylactic, giving the dates of immunization. (Par. 1. G. O. 4, 1915—2240717, A. G. O., as amended by Par. IV, G. O. 23, 1915—2273630, A. G. O.) Civilian camp followers and civilian employees, especially cooks, should be immunized immediately after employment. Paratyphoid fevers are similarly controlled.

"The prophylactic prepared by the Army Medical School contains 1,000,000 killed typhoid bacteria and 750,000 each of paratyphoid A and B per c.c. It is injected by a hypodermic syringe at from 7 to 14-day intervals, ½ c.c. at the first injection, 1 c.c. at the second and third. The skin is painted with iodine at the point of injection, before and after injection. Usually there is no reaction, excepting a slight redness and tenderness at the point of puncture, but slight headache, malaise and moderate fever develops in a few cases. As a result of this immunization, and improved sanitary measures in general, typhoid fever has now almost disappeared from the U. S. Army." Similar precautions are to be taken against paratyphoid fever.

Cholera.—Asiatic cholera has invaded the United States on several occasions, and on several others has been arrested at quarantine. It has been imported into the Philippine Islands twice since the American occupation. During the present war it has caused serious losses to the armies in the Eastern war zone, and in the civilian populations of Russia and Austria. The disease is carried by man from place to place. The parasite enters the body only by the mouth, and leaves it chiefly by the feces. It is very delicate, is quickly killed by sunlight, drying, or by a relatively low degree of heat. It can withstand freezing only for short periods, nor can it survive in an acid medium. Some persons who ingest it do not develop cholera as the parasites are destroyed by the acid gastric juice. Deranged digestion, especially that following the use of alcohol, predisposes to infection. Raw fruits, crude fibrous vegetables and other fermentative or irritative food seem to favor the growth of the parasite in the intestinal tract.

In communities, camps, etc., it is spread in much the same manner as typhoid fever, viz., by contact and indirect infection through water, food and flies. Unrecognized, mild cases and convalescent carriers are important agents in its spread. Healthy carriers are probably more common than in typhoid. In Manila six per cent.

of the healthy people in infected districts were found to be carriers. Preventive public measures should be along the same lines as those used to prevent typhoid fever. Particular attention should be given to removal of carriers, to the preparation and service of food by non-carriers, and to its protection from flies. Water should be boiled, all food taken thoroughly cooked, and table ware boiled after using. Facilities for washing hands in 2 per cent. phenol should be provided at latrines in the presence of epidemics. Protective inoculation has been practised in India, Japan and the Eastern theatre of the war. The prophylactic now used is similar to that employed against typhoid fever, but the period of immunity is shorter. Some authorities place it at one year, but in the Austrian service it is believed to be much less and is considered to be relatively absolute for 3 months only.

Dysentery.—Two important varieties of dysentery are recognized, the bacillary and entamebic. The former is caused by the b. dysenteriæ. Of this organism at least two varieties are recognized, the Shiga and Flexner types, but there appear to be several other closely related parasites which may cause similar symptoms. The disease is of world wide distribution and has been very fatal in armies. Prior to the present war Osler stated it had destroyed more soldiers than powder and shot.

Infection takes place by the mouth and bacilli leave the body only in the stools. In the latter respect it differs from typhoid. Its mode of distribution is similar to that of typhoid fever. Flies played an important rôle in its dissemination in the Punitive Expedition. In South Africa, Mexico, and in the western war zone, dust may have been an important factor in its spread.

Carriers and mild convalescent and mild acute cases are important agents in its dissemination. Water-borne epidemics are not uncommon. Overcrowding and lack of cleanliness facilitate its spread.

Entamebic dysentery is found in all climates but is most common in the tropics. It is caused by the entameba histolytica, a protozoan animal parasite. The disease is usually chronic with intervals of improvement and relapses. Under conditions adverse to its growth, this parasite forms spores (cysts) which will produce the disease if ingested.

Its methods of transmission are similar to those of the bacillus of dysentery. As its spores are more resistant than the bacteria of dysentery, it is believed that it may be transmitted more commonly by dust than is the b. dysenteriæ, but in this way much more rarely than by flies, contact, etc.

Prevention: The measures to prevent dysentery are similar to those for the prevention of typhoid fever. It is believed that the bacillus of dysentery often will not cause the disease if the digestive tract be normal, but aggravates any disturbance of it, such as that caused by exposure to cold and wet, by errors in diet, etc. An attack of diarrhea appears to have a potent predisposing influence. In the presence of an epidemic great care should be exercised in eating uncooked food. Lettuce, etc., should be immersed for ½ hour in a 0.5 per cent. solution of hydrochloric acid. When diarrheal diseases become prevalent in camp, all food should be cooked. The mortality varies from 6 to 30 per cent.

One attack of bacillary dysentery produces a certain degree of immunity. This however is not absolute, as one person may have 2 or 3 attacks in a season. There is no immunity against entamebic dysentery.

Protective inoculation against dysentery has proven unsatisfactory, since the human body does not produce anti-bodies against it, with much certainty or in large quantities. Horses may be immunized however to a high degree, and the serum of immunized animals is therefore used in the treatment of the disease.

INSECT-BORNE DISEASE

The dissemination of disease by insects has been suspected for centuries but was not proven until Theobald Smith in 1893 showed that Texas cattle fever is disseminated by the tick. Several genera of insects convey infections and have caused fatal epidemics. Bubonic plague, popularly known as "the black death" carried off one-quarter of the population of Europe in the 14th Century, malaria has rendered uninhabitable some of the most fertile regions of the earth and is believed to have precipitated the fall of Grecian civilization, yellow fever has scourged tropical and subtropical America, and southwest Europe, and typhus fever has decimated numerous armies.

Biological as contrasted to mechanical transmission has been mentioned in an earlier part of the chapter. In this former the parasite is presumably a protozoan, in the latter it is almost always a bacterium. In general, insect hosts are not harmed by the parasites they transmit.

Insects transfer infections in several ways: The mouth-parts, legs or bodies may be smeared with the virus or it may remain attached to the insect's proboscis, or be contained in the dejecta, or in the digestive tract and spread when the insect is crushed. As a rule only one species or at most a single genus transmits a particular disease biologically. Malaria is confined to anopheles, sleeping sickness to glossina palpalis, etc.

The virus of some diseases may be transmitted from insects to their progeny. So far as known this occurs only in insects having an incomplete metamorphosis, as the ticks. Many insect-borne diseases are place diseases, because the insects that carry them abound only in certain localities.

In some diseases a period of incubation in the insect is necessary, during which the parasite develops.

The most common insect carriers are the mosquito. the common fly, the flea and the louse. Less common are ticks, sand flies, and bed bugs

Mosquitoes.—Several varieties of mosquitoes transmit disease. Malaria is transmitted by Anopheles, yellow fever by Stegomyia, now called Ædes, and dengue and elephantiasis by the Culex. The genera of mosquitoes differ greatly in their habits. The Stegomyia and Culex breed about houses, frequently in artificial collections of water, the Anopheles in swamps and terrestrial waters only, as a rule. The flight of the latter is about half a mile, but they may be carried six miles or more by winds. They are soon killed by strong direct sunlight, and by storms. Both sexes subsist on vegetable matter, but the female of certain species requires a meal of blood from man or animals for the full development of the eggs. These insects lay their eggs on the surface of still water. In a day or two these hatch into larvæ and these, in turn, in about a week or 8 days into pupæ. The mature insect emerges from the pupa case in 2 or 3 days. The full period of development from the eggs to the adult mosquito is from 9 days to 3 or (rarely) 4 weeks, depending on the species,

climate and especially the temperature. A high temperature expedites development.

Some varieties of mosquitoes may live throughout the year and have been seen alive and active in Montana in January. As a rule the family is preserved in cold climates from year to year by the insects which hibernate, in barns, brush, tall grass, etc., and by the eggs and larvæ of stronger species.

Forty-nine species of Anopheles are known to transmit malaria, but some other species of this genus are unable to act as hosts. Some species can act as hosts only for a certain species of the plasmodium—but can not become infected with others. The Anopheles quadrimaculatus can convey only the parasites of tertian and quartan malaria, the Anopheles crucians only that of aestivo-autumnal fever.

Malaria is one of the most widespread of preventable diseases. It is particularly prevalent in the tropics where it often has a malignant form with high mortality. It has ravaged the southern states of the Union and is believed to have been the cause of the failure of early attempts at colonization in Virginia. The mosquito becomes infected by sucking the blood of persons harboring the malarial parasites. In the course of twelve days the parasites have multiplied in the wall of the insect's stomach and entered the salivary glands. They are discharged into the victim's tissues by the act of stinging and find their way into the red blood cells, where they grow and develop. The infected person usually does not develop symptoms for a week.

Mosquitoes are exterminated most thoroughly and cheaply by destroying their breeding places. This is effected by the drainage or filling in the pools and swamps and protection or destruction of artificial collections of water in which they breed. When drainage and filling in are not practicable, oil or larvacide may be employed. Oil forms a film on the water which prevents the larvæ and pupæ from reaching the air, as a result of which they die in about an hour. The best oil for this purpose is an intermediate grade between the illuminating and heavier crude oils. This spreads fairly rapidly, does not cost as much nor evaporate as quickly as kerosene, and gives a visible oil film. The thicker oils do not

spread as well, and for amount of surface are more expensive though they cost less per barrel.

Oiling is applicable to the water surfaces of pools, ditches, streams, shallow lagoons, edges of deep ponds, lakes and rivers and large containers, which it does not pay to cover with net. More oil is needed where vegetation grows in the water as this obstructs the formation of a complete film. An oil film will not penetrate a barrier of grass or move around it. In many waters obstructions such as sticks and stones may interfere with its uniform spread.

The quantity of oil needed for a given area can not be stated because of the obstructions that it must overcome, temperature, etc. All oils spread better in warm weather. The facility with which a given commercial quality will spread varies greatly.

Oil may be applied by several appliances. (1) A watering pot is useful for small pools. (2) A knapsack sprayer, which is operated by a pump and will throw a dirigible jet 20 feet. (3) A spraying pump installed in a small flat bottomed boat, to oil the center of lagoons, etc. (4) A drip can holding from 5 to 30 gallons for intermittent or continuous application. Usually 10 to 20 drops per minute for 1 foot breadth of the ditch will be enough to form a continuous film. The can is elevated 3 or 4 feet above the ditch so that the drops will break on impact. In many cases the drip need be operated continuously for only one or two days each week. On long ditches several cans should be used, at appropriate intervals. Though drip cans are more economical than other methods of application they tend to clog, and require frequent attention. The flow is regulated by one of several methods. The simplest is to drive a nail surrounded by cotton into the bottom of the can. The flow is regulated by the tightness with which the nail head holds the cotton against the can. A better plan is to insert a compressible flat tube about 3 inches above the bottom of the can and inserting into this a lamp wick. Two inches of water are then placed in the can and the vessel is filled with oil. Flow of fluid is regulated by compressing the tube. (5) A small bundle of cotton waste, soaked in oil, is used when the quantity of water is too small to justify the use of an oil can.

"Larvacide" was used on the Panama Canal Zone for destruction of larvæ where there was much aquatic vegetation. It was

made as follows: One hundred and fifty gallons of crude carbolic acid containing not less than 15 per cent. of phenols were heated in an iron tank having a steam coil with steam at 50 pounds pressure; 200 pounds of finely crushed and sifted common rosin were dissolved in the boiling acid, and then 30 pounds of caustic soda dissolved in 6 gallons of water were added. There was a mechanical stirring rod attached to the mixing tank. The product was ready in a few minutes, yielding about 3½ barrels. As a mosquito larvacide it was used by spraying an aqueous emulsion (one part of larvacide to five of water) over the surface to be treated and along the margin of pools and ponds or other mosquito-breeding places, so that the resulting dilution of the larvacide had a thin, milky opalescence representing approximately a dilution of 1 to 5000. A 1 to 1000 dilution killed the larvæ more rapidly, and was used for destruction of larvæ in overflowing pools, etc., and where the use of oil was not practicable.

Underbrush and high grass in which insects find refuge should be destroyed.

Mosquitoes should be destroyed in the buildings in cantonments and fixed camps. This is done by a search for them with a flash light and killing them by "swatters" or the use of a wide-mouthed bottle containing chloroform in cotton. If a dark band be painted on the wall the insects will usually light on it, and will be found very easily. Cantonments should be screened with a net of not less than 16 strands to the inch. This should be as far as possible, of copper though 5 to 10 per cent. of zinc are permissible. A good, inexpensive screening consists of 65.75 per cent. copper, 34 per cent. zinc and 1 per cent. iron. The less iron the better. In the field as a protection against malaria individual mosquito bars, head nets and gloves should be used. This is the best single prophylactic measure that is then available except the daily administration of quinine.

Prevention of malaria by the use of quinine has given good results. Authorities differ in the dosage that should be used. Celli's method, using a dose of 6 grains of quinine daily has given excellent results in the Italian army. It should be given to all troops in malarious regions daily at retreat. If daily dosage is not practicable 15 grains should be given every other day.

Many persons in malarious regions who appear perfectly healthy, harbor the parasites of this disease and are therefore foci of infection. The proportion of such carriers varies widely in different districts. An average of the data collected by Craig shows that about one-third of the children and one-fourth of the adults in malarious regions are carriers. These persons have at least one parasite in the blood to each 500 white blood corpuscles. They should receive 30 grains of quinine daily until the plasmodia have disappeared from the blood, then daily doses of 15 grains for two weeks, then 10 grains daily for two weeks, then the usual prophylactic dose for at least 2 months. Acute cases should be protected from the bites of insects by screened rooms or mosquito bars and receive systematic treatment.

Yellow Fever.—Until recent years yellow fever was constantly present in Havana, Vera Cruz, Panama, and other Spanish American ports. They were foci from which epidemics spread to tropical and subtropical ports on both the Atlantic and Pacific coasts of America, as far north as Boston, to the west coast of Africa and to the southwest coast of Europe. It has been a scourge of the American continent until Major Walter Reed, U. S. A., and his collaborators demonstrated that the disease was caused by the bite of infected mosquitoes. The officers showed that the mosquito is infected by biting a yellow fever patient during the first 3 days of the disease, and after about 12 days will convey the disease to the persons whom it bites. These then develop the disease in from 3 to 5 days, this being the period of incubation. The yellow fever mosquito, (Ædes calopus) has a wide area of distribution, ranging from 40° north latitude to about 40° south. It is found in China and Japan, the East and West Indies, the Philippines and the Hawaiian Islands. The insect breeds as a rule in artificial collections of water, is usually found near dwellings and has a short radius of flight, probably not over 75 yards. It will not travel even a short distance over water so that a vessel moored 1200 yards from shore is entirely safe from its unaided approach.

There is no natural immunity to yellow fever but an attack confers immunity which lasts throughout life. Many persons living in districts where it is endemic have mild and unrecognized attacks in childhood which give them life long immunity. It is these mild

cases which are not recognized as yellow fever, which facilitate the spread of the disease, for they are unrecognized and are not protected from the bites of mosquitoes.

Prevention of this disease may be accomplished by: (1) the protection of all known and suspected cases from the bites of mosquitoes; (2) protection of healthy people from the bites of mosquitoes; (3) destruction of adult insects and (4) control of their breeding places. Patients should be isolated in compartments screened with a mesh of at least 18 strands to the inch. A mesh of 16 strands is usually adequate but not invariably so, as the Ædes is a small mosquito. Houses in infected localities should be protected in the same manner. As soon as a patient is removed from his room and before mosquitoes have a chance to escape it should be disinfected with sulphur dioxid 2 lb. per 1000 ft. Breeding is controlled by screening or oiling tanks, cisterns, etc., and eliminating standing water in and about households.

The prevention of yellow fever is much simpler than is that of malaria, for the Ædes does not fly far and its breeding habits are easily controlled. Further, a patient is infective only in the first 3 days of the disease and thereafter is immune—is not a carrier.

Dengue.—Dengue, or breakbone fever, is an acute disease, occurring in epidemic form in tropical and subtropical countries. It is characterized by severe pains in the muscles and joints and by an eruption similar to that of measles. It rarely ends fatally, but is sometimes followed by a protracted period of debility.

The disease is constantly present at the beginning of the rainy season in the Philippines. Epidemics have occurred along the Mexican border, but not in very recent years. It is important that the disease be differentiated from yellow fever with which the early cases of an epidemic have sometimes been confounded. The cause of the disease has never been identified. It is transmitted by the Culex fatigans, a mosquito common throughout most tropical and subtropical regions, and by the Ædes calopus.

Preventive measures are the destruction of the breeding places of mosquitoes, the protection of patients from their bites, screening of houses, etc. The culex mosquitoes breed at a distance from houses, as well as in their vicinity, and have a strong flight. The

measures used must be carried further afield than those for destruction of the yellow fever mosquito.

Flies.—Household flies are found in practically all parts of the world, except the coldest regions. They are 99 per cent. of the flies caught in houses. In summer camps they abound, unless measures be taken to prevent their breeding. They are especially abundant in cattle and horse raising countries. In some localities they are replaced in a whole or in part by other similar species which have a comparable effect however in transmitting diseases. Eggs are laid preferably in horse manure, but also in human excreta, manure of pigs and other animals, decaying animal or vegetable matter, especially if soiled with excreta, kitchen refuse, etc., and polluted soil. About 120 eggs are laid at one time. Several insects usually deposit their eggs in the same spot, so that they appear in small irregular clusters, from ¼ to 1 inch in diameter. The eggs hatch in from 8 to 24 hours and the maggots which emerge reach their full size (about ½ inch long) in about 4 days. Prior to this they have kept below the surface feeding on the organic matter but now they migrate to find a suitable place for the pupal stage. This is usually the edge of the manure pile, or near it on the ground. The pupa is nearly cylindrical, from yellowish to dark brown in color. This stage lasts from 5 to 10 days. The total time from laying eggs to emergence of the adult fly is from 8 to 15 days, usually 10 days. In cold or dry weather it may be many months. As a rule flies lay only once or twice but six or seven generations may develop during a summer. The species is perpetuated over cold weather by the impregnated females and pupæ who have found shelter. Maggots scattered with manure may be destroyed by dryness. Flies transmit disease by conveying germs on their feet or other parts of the body, by vomiting liquids from their crops or by voided intestinal contents in fly specks. Each fly has about a million germs on its body but as a rule these die in a few hours. Disease carrying germs may live several days in the crops and even longer in the bowels of these insects, yet retain their full virulence when discharged. As a fly consumes about its own weight of food daily and defecates every few minutes, its chief danger is through the fly specks it leaves. It is a common agent in the transmission of cholera, typhoid and paratyphoid fever, dysentery, and other

diarrheal diseases. It is also said to transmit the germs of tuberculosis, yaws, trachoma, plague, small pox, leprosy, anthrax, ophthalmia, erysipelas, tropical sore and the eggs of parasitic worms.

Frequently it is accused of transmitting diseases without adequate proof, and some authorities believe that its importance in this rôle has been overestimated. But that flies are important agents in the spread of a number of diseases, especially those affecting the alimentary tract is quite beyond doubt.

The influence flies exert in the transmission of disease is controlled by (1) destruction of the insects breeding places, (2) destruction of adults and (3) prevention of their obtaining access to food. The methods by which these ends are accomplished are discussed in the chapter on camps.

Diarrhea.—Diarrhea and dysentery may, in war, cause more deaths than typhoid fever. They increase in severity usually as war progresses. They caused 57.265 deaths in the federal armies during the Civil War corresponding to a yearly mortality of 17 per 1000 or one death out of every 3.5 deaths from all sickness.

Simple diarrhea may follow the use of indigestible, unwholesome or excessive food. It is prevalent among newly raised troops when cooks do not understand field cooking. Also it is caused by fermentation or putrefactive organisms. Attacks are precipitated by exposure to inclement weather, by damp soil and breathing foul air, all of which probably act by lowering bodily resistance. It may be caused by changes from a soft to hard water, by inorganic impurities in water, such as the calcium or magnesium salts, or by diet or by bacteria.

Those parasites most frequently indicted are mentioned in an earlier part of this chapter. Most epidemics of diarrhea are of an infectious character and are spread by flies, contact, etc. In camps, especially, diarrhea often is contagious and is spread in the same manner as is typhoid fever. It appears that some of the ordinary harmless bacteria in the intestinal canal may assume pathogenic qualities when special conditions arise.

Many outbreaks of what was formerly known as "diarrhea" were in all probability typhoid fever or more frequently some form of dysentery. Outbreaks limited to companies or those subsisting at a general mess are usually due to ptomaine poisoning.

Fleas.—Fleas are important from a sanitary standpoint, because of their agency in transmitting plague. The insects lay their eggs in the hairs of their hosts, whence they fall freely to the ground. Larvæ emerge in from 3 to 5 days and in from 5 to 8 days more metamorphosis is complete. Both the male and female are capable of biting.

Over 300 species have been described. As a rule each species prefers certan species of animals as hosts, but often attack others. Plague is transmitted by the Indian rat flea (Sæmopsylla cheopis), the common rat flea of Europe and America (Ceratophyllus fasciatus), the cat flea (Ctenocephalus felis), the squirrel flea (Ceratophyllus acutis), the human flea (Pulex irritans), and probably by other genera and species. It is stated but not yet proved, that they may also act as agents in the spread of typhus fever.

Plague is primarily a disease of rats, and epidemics among human beings are carried by extensions to them of epizoötics of the disease among rats. When a rat dies of this disease the fleas seek a new host and thus spread the infection to other rats or to man. In this transmission the flea's rôle is mechanical only. If its mouth parts are infected its bite will cause the disease, or if its body be crushed and the wound caused by its bite scratched, plague bacilli may be rubbed into the wound. The bacillus pests can live 15 days in the alimentary tract of a flea that has ingested infected blood.

Plague.—Plague is an acute disease, characterized by swelling of the lymphatic glands (bubonic plague), hemorrhages into the skin and mucous membranes, and, in some cases by pneumonia (pneumonic plague). It has a high mortality. The pneumonic form is especially fatal. Plague has caused more deaths than any other epidemic disease except small pox. It is conveyed usually by the rat flea but during the epidemic in San Francisco in 1907, the common ground squirrel or gopher was found to be infected and to be harboring fleas which transmitted it.

The pneumonic form of plague is also transmitted by contact and by droplet infection.

The prevention of plague is effected chiefly by destroying rats, for in their absence fleas do not spread the disease. The measures for this purpose are removal of their food supplies, elimination of their habitats, destroying them by natural enemies, traps, and

poisons. Since rats thrive on human food and garbage, all food containers should be rat proof and organic waste destroyed. The animals live and multiply in the walls and partitions of houses, wharves, stables and outhouses, and in burrows under buildings. The last mentioned are made rat proof by stopping the rat runs by concrete or sheet iron. Wharves are protected from invasion by rats from ships by rat guards on the ship's hawsers. Traps should be placed along runways. The spring trap is far more economical than is the cage trap. If food is abundant, trapping is relatively futile. The bait should be different from the material that rats can obtain otherwise where the trap is set. Baits for traps are Vienna sausage, fried bacon, oatmeal, toasted cheese or toasted buttered bread, fish, liver, raw meat, etc.

Poisoned baits in Manila proved lowest in efficiency but highest in economy. Only seventy-two rats were killed for each 10,000 baits set. A favorite formula is a mixture of 1 pound of oatmeal, 1 pound of coarse brown sugar and a spoonful of arsenic. Phosphorus may be used in proportion of 2 parts of yellow phosphorus to 98 of glucose.

Fleas in cantonments, etc., are destroyed by scattering flake napthalin on the floors and closing doors and windows for 24 hours.

Protective inoculation against plague has been practised with good results in India and in Manchuria.

Lice.—Lice are biting, blood sucking insects, parasitic on man and warm blooded animals. The eggs are usually attached to the hair of the host, or to the garments of man. They hatch in 10 or 15 days, and the insects moult 3 or 4 times before reaching maturity. Several generations develop each year. They do not change hosts so readily as some other parasitic insects. About 60 species exist of which three are found on man: the head louse (Pediculus Capitis or Humanus), the clothes or body louse (Pediculus Vestimenti or Corporis), and the crab louse (Pediculus Pubis). The first mentioned is found in the hair of the head, the second especially on the clothing and the third on the parts of the body covered with short hairs, as the pubes, axillæ and eye brows. The body louse and the head louse are the agents in the transmission of typhus fever, possibly also the crab louse. The duration of life on the body is not known. The longest known period that they survive separation

from the host is 9 days. Eggs separated from the body may remain dormant 40 days.

Ninety-five per cent. of the men in the trenches examined by Peacock were found infested. Men in the bare trenches and in dug outs were equally infested.

Usually there were twenty lice per man. Clean underclothing becomes infested in half an hour. The main source of infestation is the eggs on the clothing of the men themselves. Blankets are of minor importance as harborers and centers of dissemination. The sources of dissemination mentioned by Peacock are: (1) living places, dug outs, billets and bivouacs; (2) material, *e.g.*, blankets, straw and beds; (3) the soldier himself and his clothing and equipment. It is believed that the insects transmit typhus fever mechanically in the act of biting. The claim that a period of development in the body of the louse is necessary, has not been established.

Typhus Fever.—Typhus fever is an acute disease characterized by great prostration, severe nervous symptoms and a peculiar skin eruption. The duration of an attack is about two weeks. The death rate varies from 10 to 50 per cent. The organism carrying the disease is present in the blood throughout the febrile period and sometimes for 36 hours after the crisis. One attack usually confers immunity; mild types caused by attenuated virus have been described under the name of Brill's Disease and tabardillo. The disease has occurred in widespread epidemics. It has been common among those subjected to overcrowding, uncleanliness and general unhygienic conditions. During the Crimean war it caused many fatalities and during the present war has been especially prevalent in Servia. Means of prevention are discussed in the chapter on Personal Hygiene.

DISEASES SPREAD BY DISCHARGES FROM THE NOSE AND MOUTH

The principal affections spread by discharges from the nose and mouth are tuberculosis, pneumonia, cerebro-spinal fever, diphtheria, scarlet fever, measles, influenza, mumps and common colds. In all these ailments, man, is the chief source of infection. Tuberculosis however is also contracted through the milk of infected cows. Direct personal contact has a highly important rôle in the spread of

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then become more active, are disseminated, and cause symptoms of infection to appear. The most common form in adults is pulmonary tuberculosis.

Preventive measures comprise those indicated by the rules given above. The sputum of all patients should be destroyed, rooms and articles recently used should be disinfected, and every effort made to promote vitality, by fresh air, sunlight, food, sleep and exercise.

Pneumonia.—Pneumonia is caused by four varieties of related organisms, some of which are found in the mouth of healthy persons. The variety that causes the highest mortality is rarely found except in cases of disease.

Pneumonia is the most common cause of death in the United States Army. The disease occurs at all ages, but is most prevalent during the winter months. The mortality is from about 22 per cent. for young adults to 40 per cent. or higher in young children and the aged. Prevention consists in avoiding contact, either direct or indirect, ventilation and avoidance of cold and wet or other debilitating influences.

Cerebro-spinal Meningitis.—Cerebro-spinal meningitis may be caused, by a number of parasites—*e.g.*, those of influenza, tuberculosis, and pneumonia, but, the name as commonly employed applies to a disease caused by the diplococcus meningitidis. This organism in time of epidemics is found in the secretions of the mouth and nose of many normal persons. The disease is spread chiefly by healthy carriers. Preventive measures are similar to those adopted in pneumonia. The mortality in different epidemics has been from 20 to 70 per cent., but has been notably reduced by antitoxic serum (especially Flexner's) introduced into the spinal canal.

Diphtheria.—This is an acute disease characterized by patches of false membrane usually in the throat or nose. It is caused by a specific bacillus which may be found in the throats of healthy persons. The disease is spread chiefly by mild cases and convalescents. Preventive measures include isolation of the patient until laboratory examination reveals that he is free from the parasite, the destruction of infected discharges, avoidance of contact and administration of antitoxin.

Scarlet Fever.—This disease is attended with a skin eruption, which is usually diffuse, but may appear only on the soles of the

feet. Sore throat is another common symptom. It is transmitted chiefly by carriers. Contagion takes place through the secretions from the mouth and nose, and not through the desquamating skin. Preventive measures are similar to those already indicated.

Measles.—Measles was the second most common cause of death in the U. S. Army in the fiscal year 1915–1916. It is spread only by discharge from the nose and throat. Apparently third parties are not carriers. They become infective before the rash appears for which reason fully adequate preventive measures are in effect impossible. This difficulty is aggravated by the fact that at this time the organisms causing the disease are most resistant. An attack usually confers immunity. Preventive measures are the prompt segregation of patients who have developed measles, and in the presence of an epidemic the employment of nasal and buccal sprays in all cases of common colds. Many of these eventually prove to be the initial symptoms of measles. Also during epidemics every man who has not had measles should report daily for medical examination. Patients are usually isolated from 10 to 14 days, though recent authorities state that 7 days is sufficient. Death usually occurs as a result of streptococcic pneumonia, which gives a mortality of from 82 to 92 per cent. The most essential point in the treatment of measles is the avoidance of this or other complication. Cold and draughts are especially to be avoided.

Influenza.—Grippe is a highly contagious disease usually affecting the upper air passages, but it may manifest itself by symptoms referable to almost any organ. It is one of the most protean of diseases. It occurs in widespread epidemics and attacks a large proportion of the population. The cause of the disease is a bacillus which is disseminated by discharge from the mouth and nose. Carriers are common. Its mortality is comparatively low.

Mumps.—Mumps like measles is contagious before the disease manifests itself, and is disseminated by secretions from the mouth and nose. It is usually spread by direct contact—rarely by indirect contact. A patient may remain infectious for as long as 6 weeks after the symptoms have disappeared.

Small Pox.—This disease is mentioned here only to call attention to the fact that all persons entering the military service of the United States are required to be vaccinated promptly. This vac-

cination is repeated twice at weekly intervals, unless a "take" has occurred, and upon reenlistment. A notation showing whether vaccination was successful or unsuccessful is made on each man's descriptive list.

Trench Fever.—There has appeared among the troops on the western front, a disease heretofore unrecognized. This is known by the name of Trench Fever. It has occurred only among men from the trenches or near them, and men of the Royal Army Medical Corps. Its incidence is not affected by age, service or disparities of comfort occasioned by military rank. The incubation is from 6 to 22 days.

Two types of this fever are recognized. It is not yet fully established that the two are separate entities. Both types have identical initial histories and symptoms, and differ only in their course.

Class A. The patient feels suddenly ill, and experiences headache, dizziness and pains in the legs. He may be overcome so suddenly that he falls down. Location of maximum area of headache varies. Pain behind the eyes is common especially when they are moved. Pain also occurs in the lumbar region and the lower limbs, where it may be confined to the shins. It is often present in the thighs and behind the knees, and is deep seated. Restlessness is common. A tendency to constipation often occurs. Fever varies from 103° or 104° in the first day or two. The face is flushed, and eyes are clear and bright. Bronchial catarrh is absent. Sweating occurs. The tongue is furred and anorexia exists. The pulse rate is only slightly increased and usually rises to about 100. About the third day the temperature often falls to normal or subnormal without abatement of symptoms. Thereafter the fever rises to fall again about the sixth or eighth day. In some cases this intermission does not occur, but the temperature remains elevated for about a week, when it then falls. Symptoms immediately ameliorate. In many cases there is a single relapse, occurring within four days after the temperature reaches normal. It lasts one or two days, is attended with fever of 100° or 101° and is followed by a slight recurrence of the former symptoms.

Class B. The chief distinction between this type and the first is the number and periodicity of the relapses. The disease has the

character of a true relapsing fever. The initial attack, which presents the same symptoms as Class A, lasts about 3 days. This is followed by a variable number of days (usually 4) of good health after which the symptoms recur. Fever may rise to 103.8°. This is the first of a series of such attacks and each is sharper, the temperature higher and the symptoms just as severe as in the initial attack. The fever falls to normal in about 36 hours. The periodicity of relapses varies. After the second and third relapses most of the symptoms ameliorate, but the pains in the shins remain. Patients often can foretell the onset of a relapse. In both types the only constant blood change is a pronounced punctate basophilia.

Trench fever is differentiated from typhoid and paratyphoid fevers by the negative blood cultures, examinations of the stools and urine, and Widal examination and by the periodicity of relapses. Malta fever was excluded by agglutination tests, dengue by the absence of a rash, and influenza by the absence of bronchial catarrh, a lower degree of prostration and the periodic relapses. Malaria and relapsing fever were excluded by the absence of parasites in the blood. The disease can be transmitted experimentally by the whole blood (hæmolized) but not by the serum. The method of transmission in nature is unknown.

The following indicate approximately the incubation and segregation periods of some infectious diseases. Authorities differ on such figures.

Usual number of days	Incubation	Isolation	
Cholera	3 to 6	12	
Chicken pox	4 to 16	20	
Diphtheria	1 to 10	12	two successive negative cultures
Erysipelas	1 to 5	12	
Influenza	3 to 4	5	
Measles	8 to 14	10	
Mumps	4 to 25	21	
Plague	2 to 8	21	
Rubella	7 to 18	10	
Scarlet fever	1 to 21	40	
Trench fever	6 to 22	?	

Usual number of days	Incubation	Isolation
Typhoid fever	10 to 14	23 three negative successive weekly cultures
Typhus fever	5 to 20	14
Yellow fever	3 to 5	5 or 6

DISEASES CAUSED BY EXPOSURE

Trench Feet.—A condition common among soldiers who serve in the trenches is known as trench feet. The most important causes are cold and wet, in combination. Pressure is an aggravating factor but probably not a cause. Cold and wet, causing a rapid loss of heat, cause first a local vasoconstriction, leading to defective circulation through the feet and then to vasomotor paresis passing on to paralysis with consequent hæmostasis, œdema and gangrene. Pressure aggravates the trouble.

The onset is gradual, the feet feel cold and eventually lose sensation. Pain, except the discomfort associated with cold feet, is not complained of at first. Later, as the feet begin to swell there is pain around the ankles, occasionally extending up to the calves. If boots are removed at this time the feet swell immediately and it is impossible to replace the boots. The pathology of the condition is similar to that of Reynaud's disease. Two varieties are recognized, the red and the white. The majority of the cases resemble the former but in some the foot is dead white. This is believed to be a precursor of the congested type as the foot eventually assumes that appearance.

On admission to hospital the feet are usually in all stages of livedity from a pink blush to a dead black gangrenous appearance. They are greatly swollen, the skin is covered with bullous eruptions, containing a blood-stained fluid. The discoloration is often sharply demarcated at the mid-tarsal joint. The feet are cold. In mild cases there is œdema over the tarsus with little discoloration. Often the only color change is a light pink flush, on the ball of the great toe and the tips of the toes. There is a patchy anæsthesia. In the white cases the foot is stone cold, dead white and has lost sensation.

Gangrene rarely followed even the severe cases, except that a

superficial sloughing occurs. Pain increases at night, is aggravated by warmth, and extends up to the leg. It persists long after the circulation has been restored, and the feet appear healthy. Men whose feet are greatly swollen and appear gangrenous complain of little pain. In some cases there is great tenderness of the soles of the feet after acute symptoms have disappeared.

The condition is treated by elevating the feet, powdering with boracic acid and wrapping in absorbent cotton, which is changed twice a day. Massage, twice daily, when it can be borne, gives good results. Painting with iodine appeared to benefit certain neurotic cases. Pain was treated by morphine. Other agents were unsatisfactory. Foot drill is highly beneficial to convalescents. Recurrences upon exposure are frequent. Feet and foot gear should be inspected before the troops enter the trenches. Shoes should be roomy and well greased at intervals. The junction of sole and upper especially should be attended to in order to prevent rotting of the seams. Before entering the trenches the feet and legs should be anointed with 3½ to 4 oz. of a 5 to 10 per cent. ointment of salt and lard or whale-oil. Rubber boots are much used. Trenches should be drained if possible or provided with fascines of brushwood.

Constant care of the feet is necessary. Men should be encouraged to stamp their feet, move the toes, and exercise generally. Washing the feet should be encouraged. Lukewarm water containing half an ounce of mustard to the gallon should be employed. Dried socks should be put on and the shoes dried when possible. The legs should be kept elevated when at rest.

Frost Bite.—Severe frost bite causing loss of feet or hands has been quite common in the trenches. Among its causes in addition to cold are: dampness, high winds, nervous exhaustion, over indulgence in alcohol and lack of proper rest, food, and physical exercise. To prevent it winter clothing should be distributed systematically. Garments should be loose and the circulation unimpeded by light equipments. The foot gear is most important. Soldiers in the trenches should unlace their leggins frequently and move and rub their feet briskly. The face is protected with a hood, the hands with woolen mittens. Feet, legs and hands, as well as the ears, nose and chin, are to be rubbed with a specially pre-

pared ointment containing ten per cent. of salt. When glasses are worn the metallic parts which come in contact with the skin are covered. Immobility and inertia must be carefully guarded against, especially in the case of sentinels, whose posts should be sheltered from the wind. They should be relieved frequently during the night. They must be cautioned against standing still and yielding to drowsiness. Forty-eight hours should be the limit of service in the trenches. Alcohol is strictly forbidden in the Italian service except small quantities of light wine. Medical officers establish aid stations near the advanced posts, in order to treat without delay soldiers who show evidences of succumbing to cold, *i.e.*, by drowsiness. Hot bouillon and coffee are served to sentries on coming off duty and if necessary the patient is sent to the rear. In extreme cases he must be treated at the aid station by artificial respiration, massage and cardiac stimulation. Hot applications are to be avoided in every case of frost bite. No alcohol is given. Blisters are emptied and great care is exercised to avoid infection and subsequent gangrene. In every case of frost bite with skin lesions, anti-tetanus serum is injected.

Gas Poisoning.—Information on this subject is of a confidential character and can not now be noted here.

CHAPTER VIII

ILLUSTRATIVE REGULATIONS CONCERNING FIELD HYGIENE AND CAMP SANITATION

The following regulations cover some essential measures for moving commands, for camp for a few days, and for permanent camps. They are taken chiefly from the Field Service Regulations; General Orders 13, Headquarters Southern Department, dated July 10, 1916; and Bulletin 22, Headquarters Southern Department, dated August 5, 1916.

FOR MOVING COMMANDS

1. **Camps.**—Camp sites will be selected and established in conformity with paragraphs 238 to 242, F. S. R. 1914.

2. A guard will be placed over the water supply, if the latter is of doubtful purity, and will allow none but authorized persons to have access to it.

3. Water of doubtful purity will be purified before use.

4. Men will fill their canteens before leaving camp, and will not refill them except from authorized sources.

5. Men will be allowed to drink water on the march only when authorized to do so and then in limited quantities. Company Officers will be held strictly responsible for the enforcement of such orders.

6. On long marches and in arid regions when the supply of water can not be renewed as required, a reserve supply will be carried on the wagons.

7. Trench latrines, 2 feet deep, of the straddle type will be dug immediately upon arrival in camp.

8. Men will cover their deposits. A permanent detail will fill in latrines and police camp immediately before the march is resumed.

9. The camp site will be kept well policed, and soiling of the same by refuse, remnants of food, or dirty water, is prohibited. Any pollution of the camp site is forbidden.

10. **Food.**—(*a*) Fresh meat, bread and vegetables will be inspected by a Medical Officer as to quality, when issued.

(*b*) Food will be prepared and served in a cleanly manner. It will habitually be protected against sun, dust and flies.

(*c*) Company cooks, mess equipment and kitchen areas will be kept clean and neat at all times. The kitchen police will be a permanent detail. Suspected carriers of disease will be relieved from duty in the kitchens until recovered.

(*d*) Individual mess kits will be cleaned at the cook-tent immediately after use. Cooks will provide a supply of boiling water for this purpose.

(*e*) Kitchen utensils will be cleaned thoroughly with soap and boiling water, immediately after each time of using.

(*f*) The keeping in tents of uneaten portions of food and rations is strictly prohibited.

(*g*) Men will not patronize fly infested or dirty places in which food, ice cream or drinks are sold.

(*h*) No hucksters will be allowed in camp, except for the delivery of supplies to general messes.

(*i*) The bringing of melons into camp is prohibited.

(*j*) Itinerant vendors will be allowed to sell to troops in the vicinity of the camp, only such articles as are in original packages. The sale of all beverages is prohibited.

(*k*) To enforce this order a guard will be posted, if necessary, near the vendor, to prevent men from making unauthorized purchases.

11. **Kitchen refuse** will be burned. That which is incombustible will be passed through the fire and buried in pits dug for that purpose.

12. Greasy water will be evaporated in kitchen pits. Such wastes will be reduced to a minimum.

13. **Tents** will be ditched if the weather is inclement or unsettled.

14. **Personal Hygiene.**—Men will preserve cleanliness in tents, clothing and persons. Bathing after the march will be encouraged.

15. Company Officers will exercise personal care in providing their

commands with properly fitting clothing, especially shoes and socks. The internal measure of shoes will be at least ½ inch longer than the foot.

16. A Medical Officer will inspect the feet of infantry soldiers at frequent intervals until, in his opinion, the men have learned to care for them.

17. Semi-monthly inspections of the command will be made by a Medical Officer to determine its cleanliness and freedom from disease. These will be made before the 15th and 30th of each month and will be attended by an Officer from the respective company.

18. Men will be instructed concerning the dangers attending illicit intercourse, the facilities for prophylactic treatment which the regimental infirmary will provide, and the penalties for failing to take this treatment as ordered.

19. The command will be protected from small pox, typhoid and paratyphoid fever.

20. Minor cases will be treated at the regimental infirmaries.

21. Patients with a temperature of 101° or over, will be transferred without delay to the hospital.

FOR CAMPS OF A FEW DAYS

In camps of a few days occupancy, the following additional regulations are recommended.

1. Manure and refuse will be hauled one and a half or two miles from camp, and to a point distant from through roads leading into camp, lest insects be brought in by passing animals.

2. Trench latrines will be dug eight feet deep, two feet wide, and eight feet long and provided with log seats. They will be burned out daily or treated with oil and lampblack if facilities afford. Otherwise each man will cover his deposit. Contents will be covered daily with ashes from the kitchen pits. The latrines will be cared for by a permanent detail, which will fill them in before the command moves.

3. Kitchen floors will be wet down daily, and covered with a thin layer of ashes.

4. Areas on which flies cluster will be burned over at once.

Fly paper will be hung from the ridge poles of kitchen tents.

Tent flies will be burned out nightly by torches, made of burlap wired to sticks and dipped in oil, by torches of dried brush or other similar devices.

5. Tent sites, bedding and equipment will be sunned and aired at least twice each week.

6. Roads through camp will be established and men and animals will travel on them exclusively, as far as circumstances will permit.

7. There will be a general police for the parts of the camp not occupied by organizations.

FOR MORE PERMANENT CAMPS

The regulations recommended for more permanent camps are appropriate modifications of those given above, as circumstances indicate, or additional regulations as follows, *e.g.*:

1. Each company will provide three fly traps for use in its kitchen and maintain the same in operation by daily renewal of bait, and emptying as needed. If the facilities permit, kitchens will be screened.

2. No water will be wasted from kitchen faucets. Soakage pits filled with rock will not be constructed aroupd faucets. Dripping water will be arrested by a stone and led away in a ditch.

3. All proper economy will be exercised in the use of water for bathing purposes. Men will bathe, as far as possible, at least twice weekly at specified hours and in regular shifts. Officers will see that no unused faucet is left open. Bathing places will be drained, or the bathing water will be removed in containers.

4. Facilities will be provided if possible where men will wash their hands before meals and after using the latrines.

5. All pools within one thousand yards of the camp will be oiled once weekly.

6. Picket lines will be burned over weekly, using one gallon of oil and fifteen pounds of straw or hay for each animal.

7. Latrines will be dug eight feet deep, two feet wide, and twelve feet long. They will be kept fly proof. If the covers warp, cracks

will be covered and the seat covers edged with burlap. Lids will be kept closed when not in use.

A closely fitting fly trap will be placed on an unused seat, over each latrine pit that has become infected with flies. Urine troughs will be flushed out and swabbed with crude oil daily. Covers will be lifted off the pits and the latter burned out with fifteen pounds of straw or hay and one gallon of crude oil before nine A. M. daily by a permanent detail. Latrine boxes will be removed when pits are being burned out. Or, if facilities exist, latrines will be treated preferably with lampblack and crude oil daily.

8. In the absence of oil or other means, the ashes from the company kitchens will be sprinkled in each company latrine daily.

9. Latrines will be established near communal places used by soldiers of different units. and cared for by permanent details.

10. Urine tubs will be placed in company streets at taps, removed, emptied and burned out with hay and oil at reveille, and sunned during the day.

11. Laundry facilities will be provided if possible. If water is piped into camp these will be established in sunny places and well drained.

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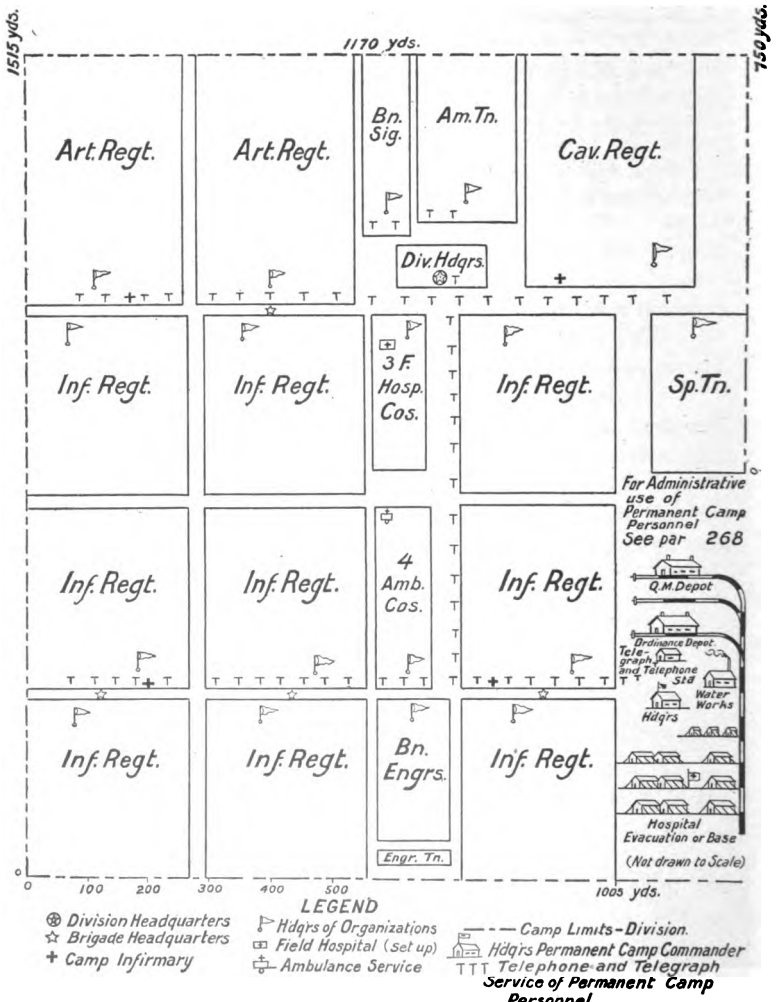


FIG. 119.—Semipermanent camps. Camp of infantry division, war strength. This form must often be modified, depending on the nature of the ground and the size of the command as prescribed from time to time in tables of organization. (*F. S. R.*)

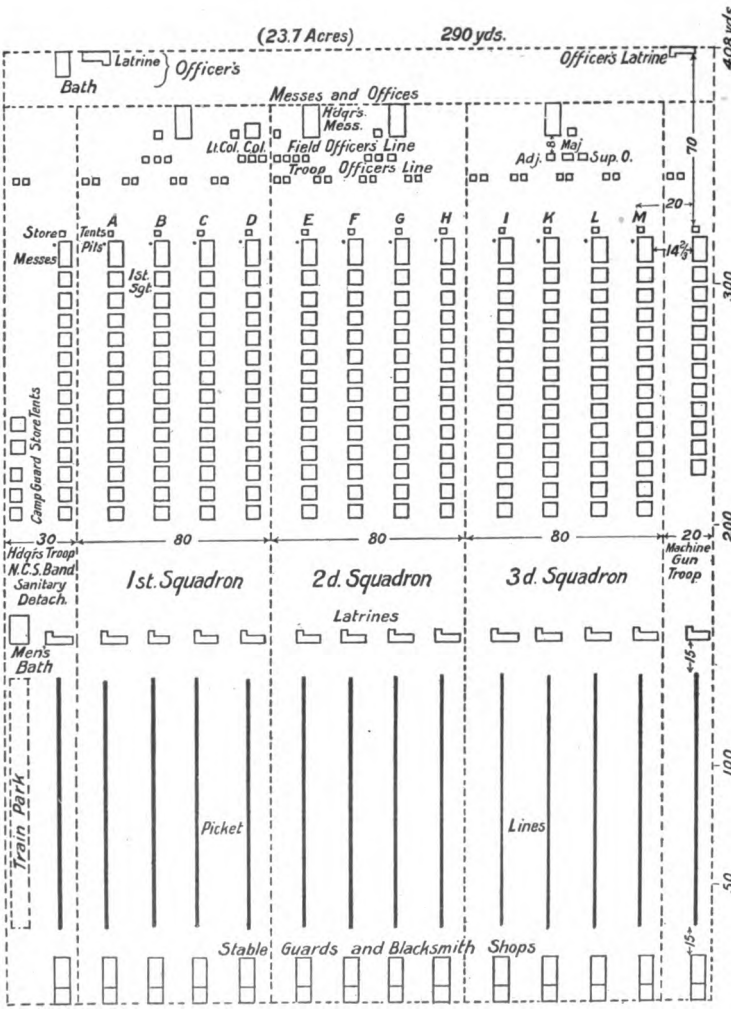


FIG. 120.—Semipermanent camps. Camp of a regiment of cavalry, war strength. (*F. S. R.*) This must be modified in area according to the size of the command prescribed by tables of organization.

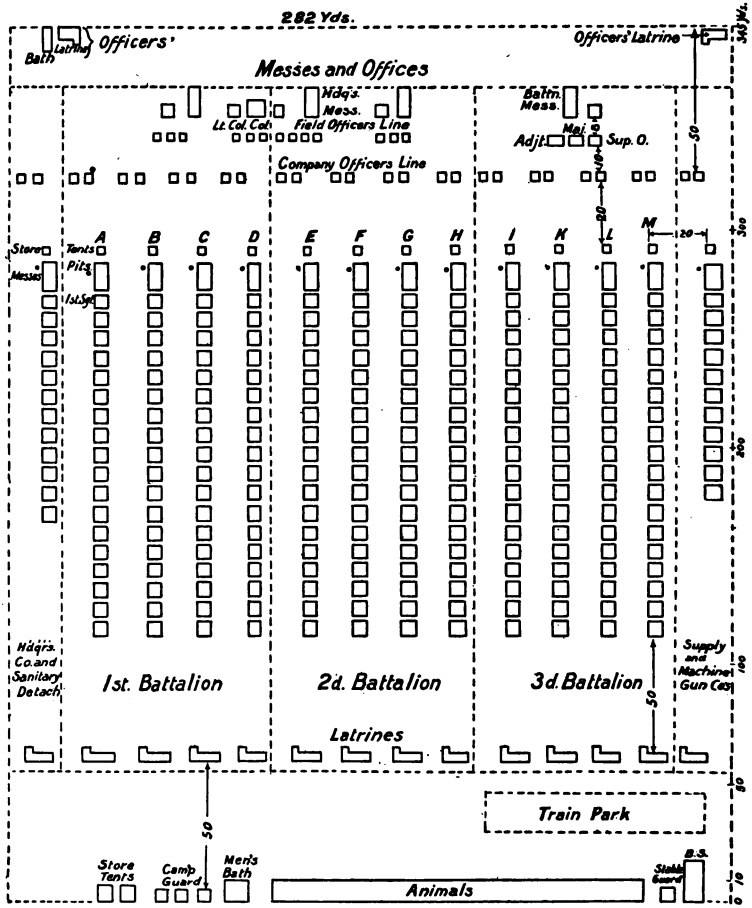
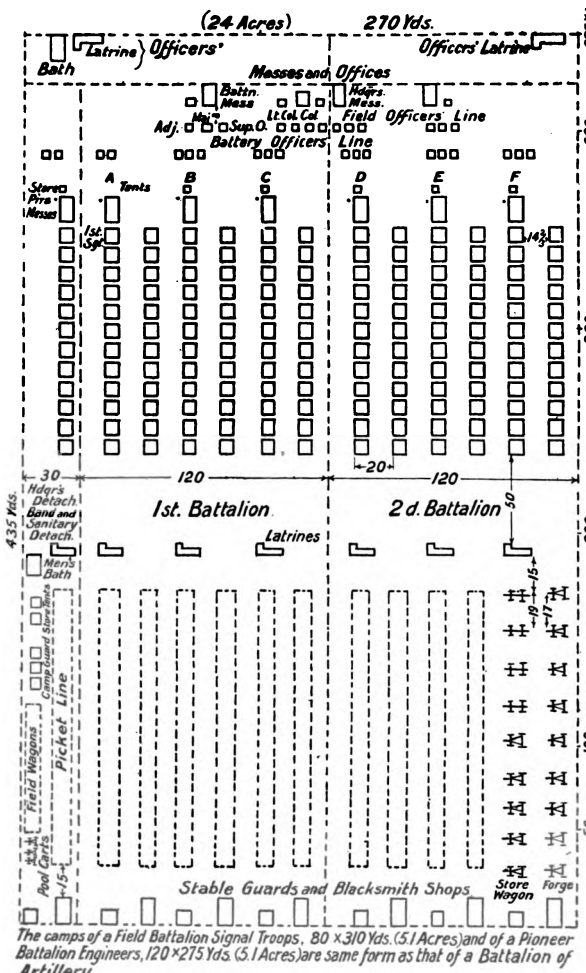


FIG. 121.—Semipermanent camps. Camp of a regiment of infantry, war strength. 19.8 Acres. (*F. S. R.*) Area modified by strength of organization prescribed from time to time in tables of organization.



The camps of a Field Battalion Signal Troops, 80 × 310 Yds. (5.1 Acres) and of a Pioneer Battalion Engineers, 120 × 275 Yds. (5.1 Acres) are same form as that of a Battalion of Artillery.

FIG. 122.—Semipermanent camps. Camp of a regiment of artillery, war strength. (*F. S. R.*) Area modified to conform to strength prescribed from time to time in tables of organization.

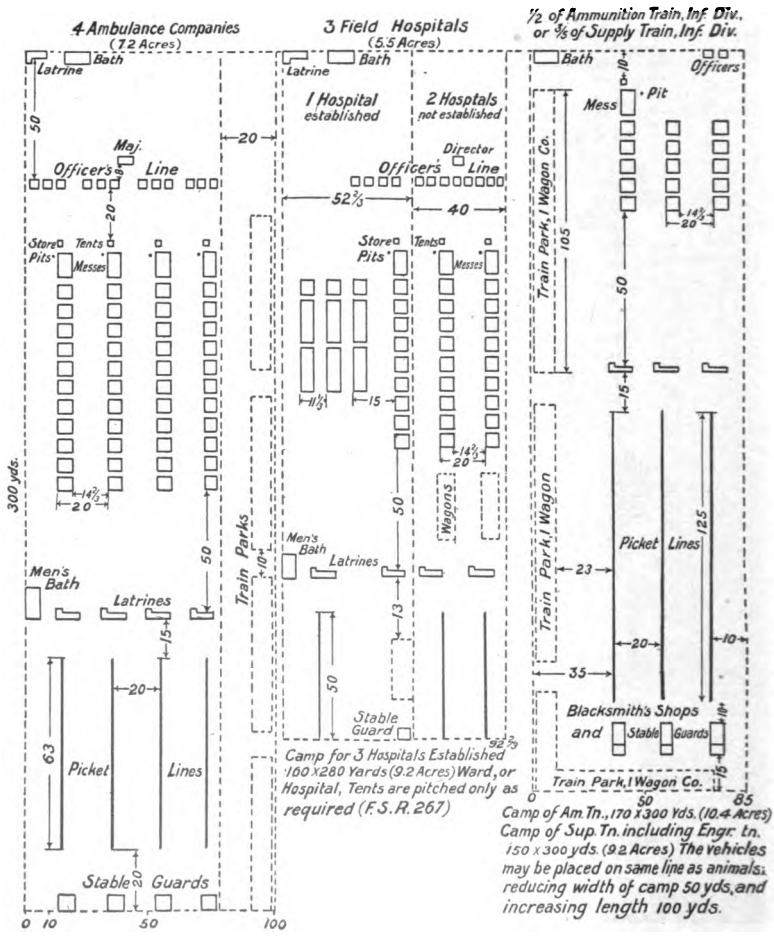

4 Ambulance Companies
(7.2 Acres)
3 Field Hospitals
(5.5 Acres)
½ of Ammunition Train, Inf. Div.
or ⅓ of Supply Train, Inf. Div.
Latrine
Bath
1 Hospital established
2 Hosptals not established
Officers
Line
Maj.
Director
Store Pits
Tents
Messes
Mess
Pit
Train Park, 1 Wagon Co.
Train Park, 1 Wagon
Train Parks
Men's Bath
Latrines
Wagons
Picket Lines
Stable Guards
Blacksmith's Shops and Stable Guards
300 yds.
Camp for 3 Hospitals Established 160 X 280 Yards (9.2 Acres) Ward, or Hospital, Tents are pitched only as required (F.S.R. 267)
Camp of Am. Tn., 170 x 300 Yds. (10.4 Acres)
Camp of Sup. Tn. including Engr. tn. 150 x 300 yds. (9.2 Acres) The vehicles may be placed on same line as animals, reducing width of camp 50 yds, and increasing length 100 yds.

FIG. 123.—Semipermanent camps. Camps of trains. War strength. (*F. S. R.*) Area modified from time to time to conform to strength prescribed by tables of organization.

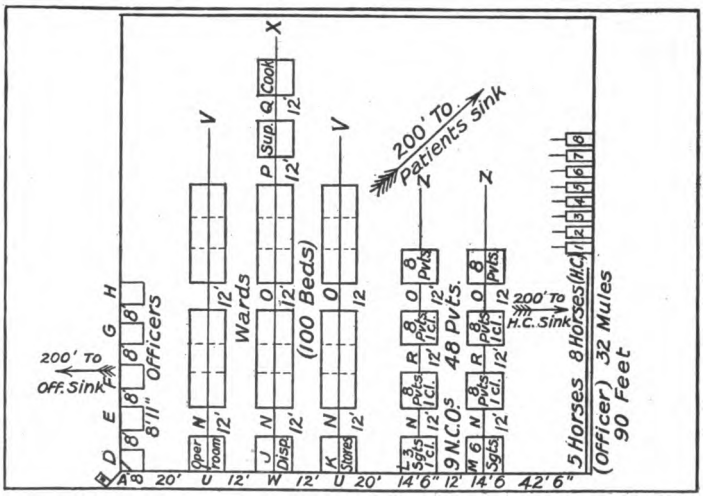


FIG. 124.—Field hospital camp. (*F. S. R.*)

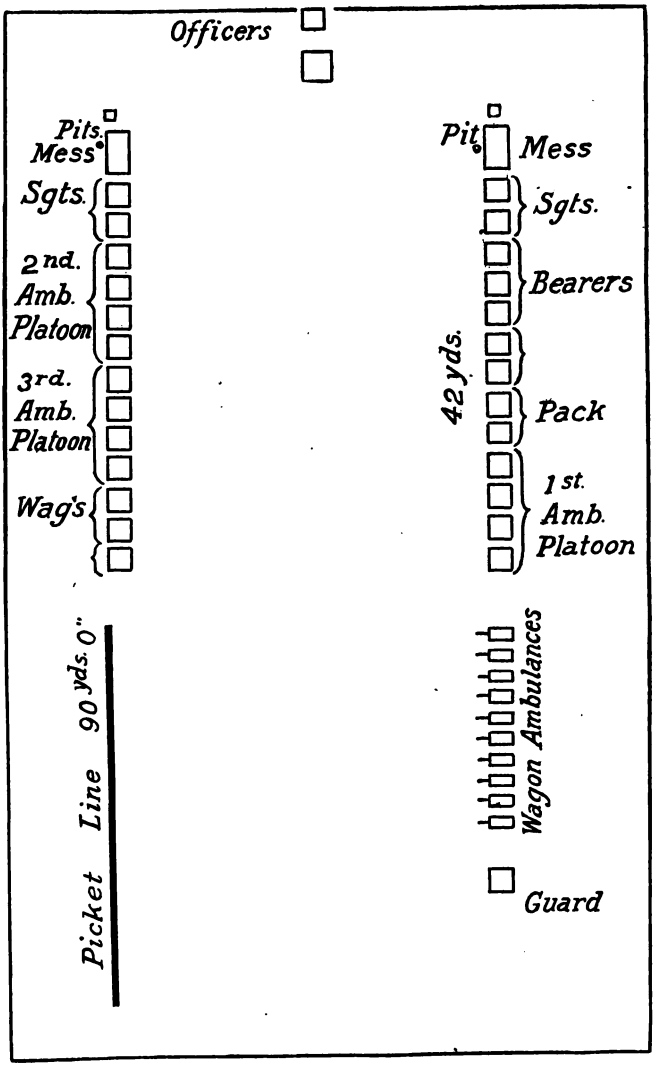


FIG. 125.—Temporary camp. Ambulance Co. 30 × 185 yds. (*F. S. R.*)

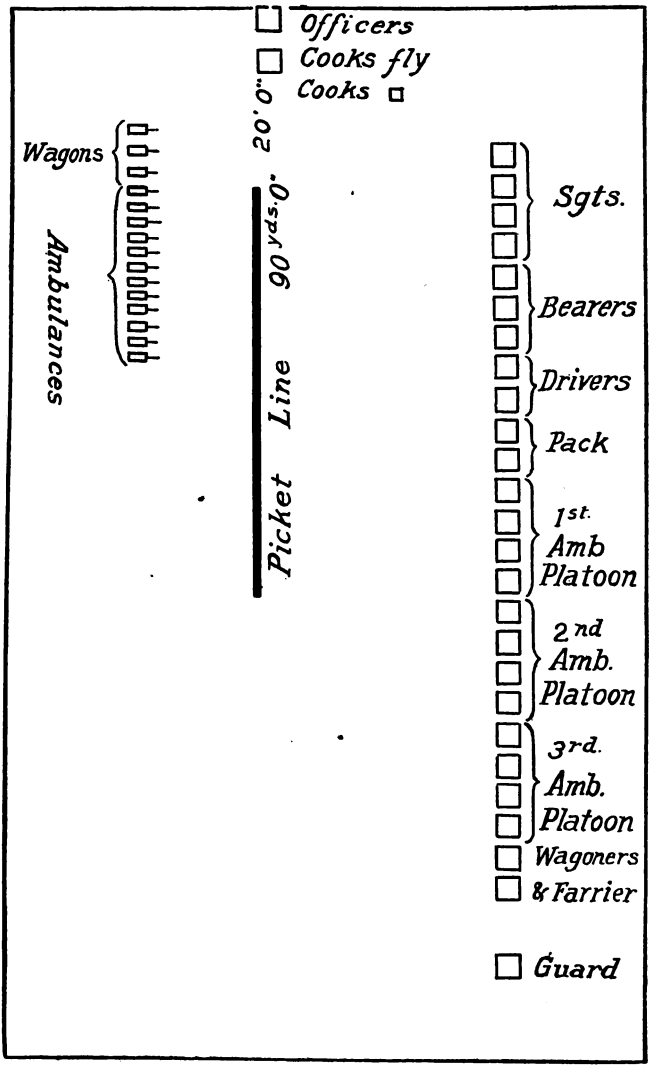
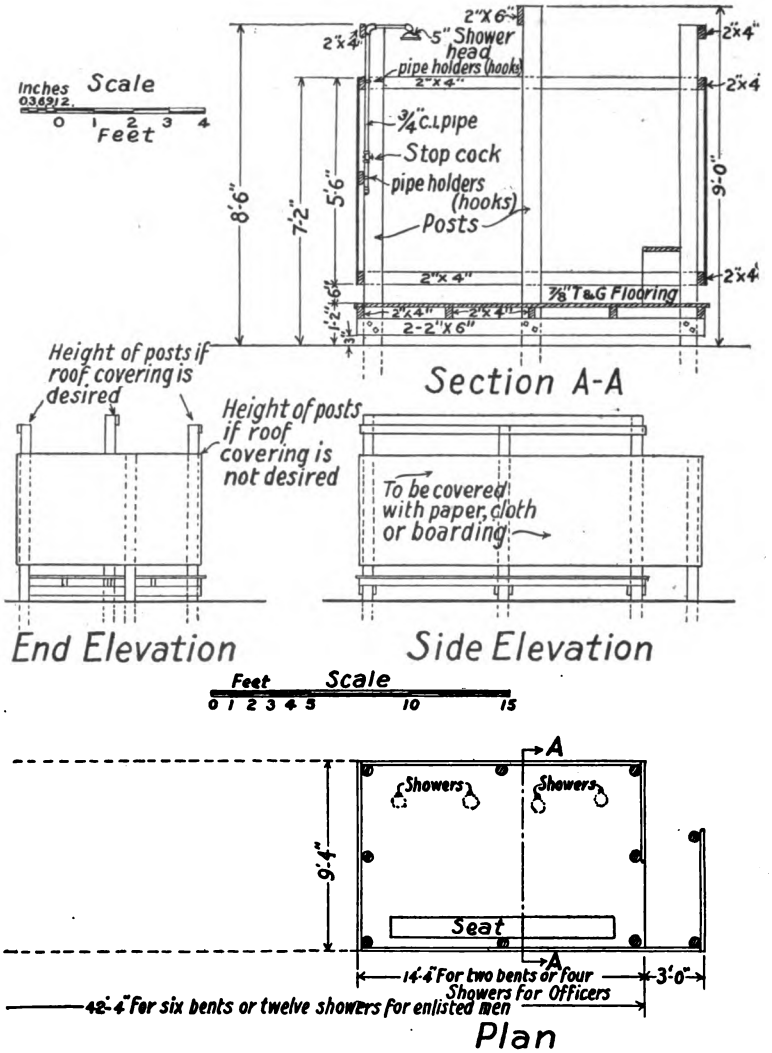


FIG. 126.—Semipermanent camps. 45 × 140 yds. Ambulance Co. (*F. S. R.*)

BILL OF MATERIALS (FIG. 127)

	Four showers for officers	Twelve showers for enlisted men
Posts	10—12′ 0″	18—12′ 0″
Sills	6 Pcs. 2″×6″×10′ 0″	14 Pcs. 2″×6″10′ 0″
Joists	5 Pcs. 2″×4″×16′ 0″	15 Pcs. 2″×4″×14′ 0″
Girts	2 Pcs. 2″×4″×18′ 0″	2 Pcs. 2″×4″×18′ 0″
Girts	5 Pcs. 2″×4″×16′ 0″	2 Pcs. 2″×4″×16′ 0″
Girts	2 Pcs. 2″×4″×12′ 0″	2 Pcs. 2″×4″×12′ 0″
Girts	2 Pcs. 2″×4″×10′ 0″	19 Pcs. 2″×4″×14′ 0″
Girts	1 Pc. 2″×4″×16′ 0″	3 Pcs. 2″×6″×14′ 0″
Seat	1 Pc. 2″×8″×16′ 0″	3 Pcs. 2″×8″×16′ 0″
Flooring T. and G	190 Ft. B. M.	525 Ft. B. M.
Boarding	52 Pcs. 1″×12″×5′ 6″	106 Pcs. 1″×12″×5′ 6″
Paper or cloth if used	320 Sq. ft.	600 Sq. ft.
Shower heads, pipe, holders, cocks, etc	4–5″	12–5″
Nails	5 lb. 16d.	14 lb. 16d.
Nails if board is used	8 lb. 8d.	21 lb. 8d.
Nails if paper or cloth is used	4 lb. 8d.	10 lb. 8d.
Labor, carpenter	15 hours.	36 hours.



Bath House

FIG. 127.—Bath house. (*Q. M. D.*)

BILL OF MATERIALS (FIG. 128)

(Wood.)

28 Pcs. 1″ × 12″ × 18′ 0″ = roofing
12 Pcs. 1″ × 8″ × 18′ 0″ = shiplap sides
11 Pcs. 2″ × 4″ × 12′ 0″ = rafters and braces
1 Pcs. 2″ × 6″ × 16′ 0″ = ridge
2 Pcs. 4″ × 4″ × 14′ 0″ = corner posts
7 Pcs. 2″ × 4″ × 14′ 0″ = studs
2 Pcs. 2″ × 4″ × 10′ 0″ = studs in gables
12 Pcs. 2″ × 4″ × 16′ 0″ = plates and sills
4 Pcs. 1″ × 4″ × 12′ 0″ = barge board
11 Pcs. 1″ × 4″ × 10′ 0″ = braces
10 Pkgs. 6d. nails
15 Pkgs, 8d. nails
20 Pkgs. 16d. nails
12 Pcs. 1″ × 8″ × 14′ 0″ = shiplap ends
8 Pcs. 1″ × 8″ × 18′ 0″ = shiplap gables
3 Pcs. 1″ × 4″ × 18′ 0″ = rafter ends and ridge
2 Pcs. 2′ 6″ × 6′ 6″ = screen doors complete
2 Pcs. 1″ × 10″ × 16′ 0″ = frieze board
20 yd. screening 36″
4 Packs tacks.

Labor, carpenter, 40 hours.

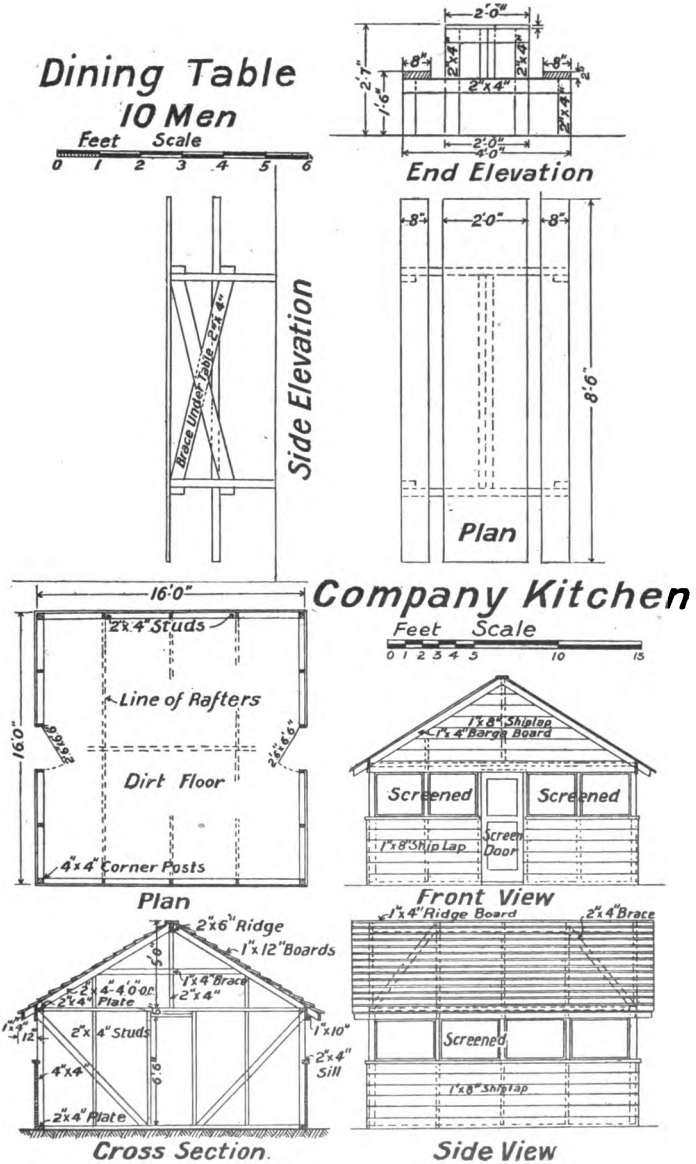


FIG. 128.—Company kitchen. (*Q. M. D.*)

BILL OF MATERIALS (FIG. 129)

25 Bbls. cement
8 Cy. sand
8 Cy. stone
24 Post piers
12 Pcs. 4″ × 4″ × 14′ = sills
3 Pcs. 4″ × 4″ × 16′ = studs and girts
30 Pcs. 2″ × 4″ × 16′ = studs and girts
12 Pcs. 2″ × 4″ × 16′ = plates
65 Pcs. 2″ × 4″ × 14′ = roof
40 Pcs. 2″ × 4″ × 16′ = roof
5 Pcs. 2″ × 6″ × 12′ = roof
5 Pcs. 2″ × 6″ × 16′ = window sills
8 Pcs. 1″ × 12″ × 16′ = shelves
4 Pcs. 1″ × 12″ × 12′ = shelves
2 Pcs. 1″ × 12″ × 10′ = shelves
8 Pcs. 1″ × 12″ × 18′ = tables
7 Pcs. 2″ × 8″ × 18′ = tables
21 Pcs. 2″ × 4″ × 16′ = tables
18 Pr. Hinges
18 Hooks or fasteners
10 Lb. 6d. nails
75 Lb. 8d. nails
60 Lb. 16d. nails
10 Lb. roofing nails
1 Lb. tacks
20 Pcs. ½″ × 4″ × 16′ = louvers and corner boards
4000 Ft. B. M. 8″ shiplap 16′ = wall and roof
4 Doors 2′ 6″ × 7′ 0″ complete
18 Sqs. rubberoid roofing
23 Yd. 36″ screening
10 Gal. cold-water paint.

Labor—Carpenter, 26 hours.
Concrete labor, 50 hours.
Painter, 24 hours.

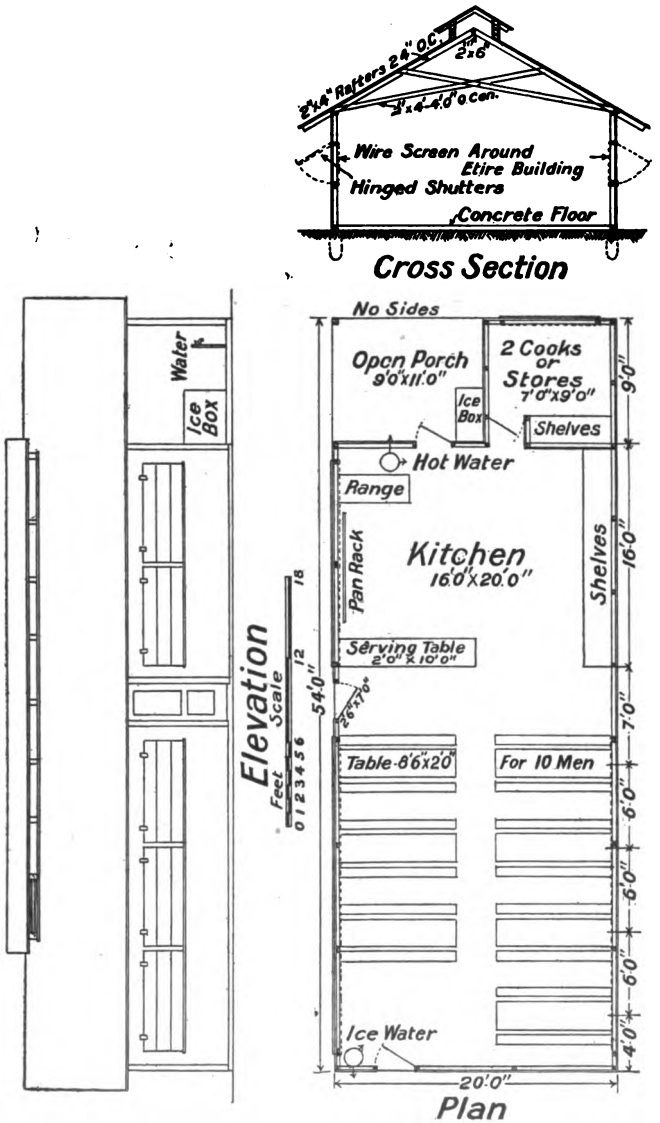


FIG. 129.—Plan for kitchen and dining room—72 men. (*Manual for the Quartermaster Corps, U. S. A.*)

Bill of Materials (Fig. 130)

	One box and enclosure	Two boxes and enclosures
Top of box	2 Pcs. 1″×12″×8′ 0″	4 Pcs. 1″×12″×8′ 0″
Front of box	2 Pcs. 1″× 8″×8′ 0″	4 Pcs. 1″× 8″×8′ 0″
Rear of box	2 Pcs. 1″×10″×8′ 0″	4 Pcs. 1″×10′× 8′ 0″
Ends of box	1 Pc. 1″× 8″×8′ 0″	2 Pcs. 1″× 8″×8′ 0″
Seat covers	1 Pc. 1″×12″×7′ 0″	2 Pcs. 1″×12″×7′ 0″
Seat covers	1 Pc. 1″× 2″×7′ 0″	2 Pcs. 1″× 2″×7′ 0″
Battens and strips (if T. and G. material is used, battens can be omitted)	8 Pcs. 1″× 2″×8′ 0″	16 Pcs. 1″× 2″×8′ 0″
Frame for box	1 Pc. 2″× 2″×4′ 6″	2 Pcs. 2″× 2″×4′ 6″
Frame for box	2 Pcs. 2″× 4″×9′ 0″	4 Pcs. 2″× 4″×9′ 0″
Front plank under box	1 Pc. 2″×10″×8′ 0″	2 Pcs. 2″×10″×8′ 0″
Rear plank under box	1 Pc. 2″× 6″×8′ 0″	2 Pcs. 2″× 6″×8′ 0″
End plank	1 Pc. 2″× 6″×3′ 0″	2 Pcs. 2″× 6″×3′ 0″
End plank	1 Pc. 2″×12″×3′ 6″	2 Pcs. 2″×12″×3′ 6″
End strip	1 Pc. 1″× 6″×2′ 9″	2 Pcs. 1″×6″×2′ 9″
Posts	10 Pcs. 10′ 0″	12 Pcs. 12′ 0″
Boarding (1″ boards or equivalent in other widths if boarding is used)	48 Pcs. 1″×12″×6′ 0″	66 Pcs. 1″×12″×6′ 0″
Battens	48 Pcs. 1″× 2″×6′ 0″	66 Pcs. 1″×12″×6′ 0″
Paper	2 Rolls.	3 Rolls.
Stringer if roof is used	1 Pc. 2″×6″×14′ 0″	1 Pc. 2″×6″×12′ 0″
Stringer if roof is used	2 Pcs. 2″×4″×14′ 0″	2 Pcs. 2″×4″× 8′ 6″
Rails	8 Pcs. 2″×4″×12′ 0″	2 Pcs. 2″×4″× 8′ 6″
Nails	3 Lb. 20d.	4 Lb. 20d.
Nails	8 Lb. 10d.	12 Lb. 10d.
Nails	4 Lb. 8d.	9 Lb. 8d.
Strap hinges	4 Pairs—4″	8 Pairs—4″
Flat head screws	4 Doz. No. 8.	8 Doz. No. 8.
Galvanized iron urinal trough	1 6″× 6″×3′ 0″	1 6″×6″×3′ 0″
Wrought iron pipe	1 1″×1¼″×1′ 4″	1 1″×1¼″×1′ 4″
Wrought iron pipe bent as shown	1 1″×1¼″×4′ 0″	1 1″×1¼″×4′ 0″
I. C. tin	1 Sheet 20″×28″	2 Sheets 20″×28″
Labor, carpenter	20 Hours	32 Hours.

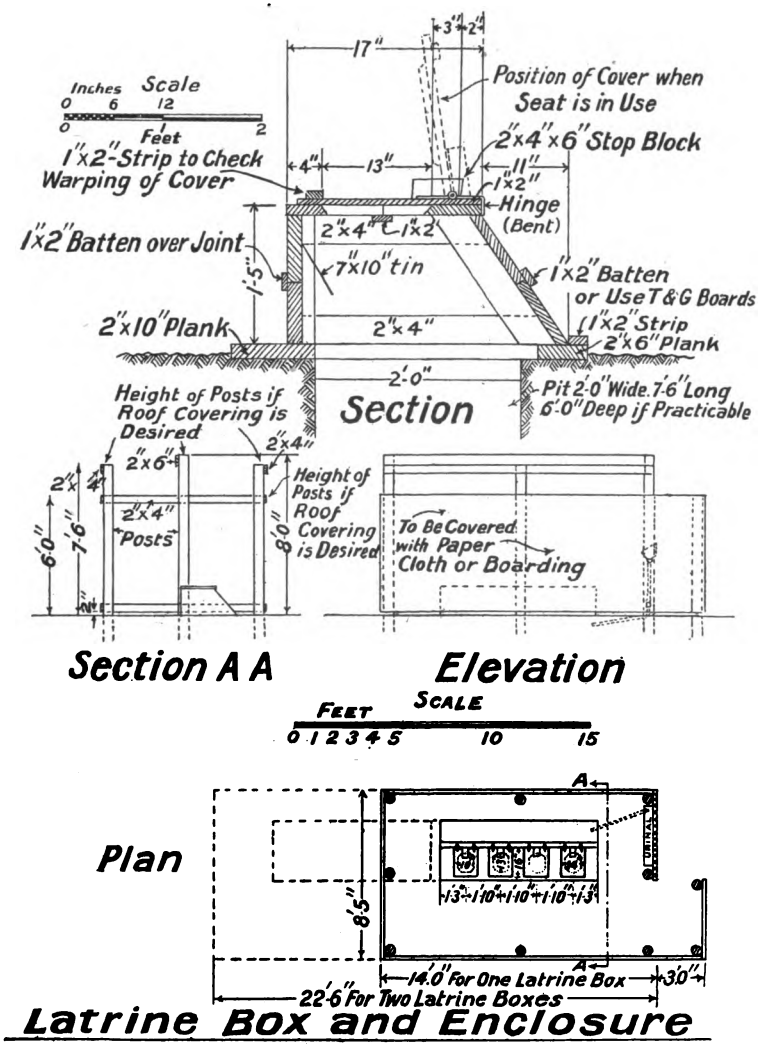


FIG. 130.—Latrine box and enclosure. (*Q. M. D.*)

BILL OF MATERIALS (FIG. 131)

(Size of paulin 17′ × 29′)

2 Pcs. 2″ × 6″ × 18′ 0″ = ridge
10 Pcs. 2″ × 4″ × 10′ 0″ = rafters
11 Pcs. 2″ × 4″ × 12′ 0″ = braces, roof
2 Pcs. 2″ × 4″ × 16′ 0″ = plates, ends
4 Pcs. 2″ × 4″ × 18′ 0″ = plates, sides
5 Pcs. 2″ × 4″ × 18′ 0″ = studs
2 Pcs. 4″ × 4″ × 18′ 0″ = corner posts
4 Pcs. 2″ × 4″ × 20′ 0″ = braces, corner
1 Pc. 1″ × 12″ × 20′ 0″ = gables
12 Pcs. 1″ × 12″ × 16′ 0″ = base boards, sides
2 Pcs. 1″ × 12″ × 16′ 0″ = base boards, ends
1 Pc. 1″ × 12″ × 14′ 0″ = footing
4 Pcs. 1″ × 6″ × 16′ 0″ = frieze boards, sides
2 Pcs. 1″ × 6″ × 16′ 0″ = frieze boards, ends
10 Pcs. ½″ × 2″ × 14′ 0″ = weather strips, paulin
6 Pcs. ½″ × 2″ × 18′ 0″ = weather strips, paulin
2–2′ 6″ × 6′ 8″ screen doors, complete
24 Yd. screen, fine mesh, 36″ wide
2 Pkgs. carpet tacks
5 Lb. 16d. wire nails
10 Lb. 10d. wire nails
2 Lb. 4d. wire nails.

Labor, carpenter, 24 hours.

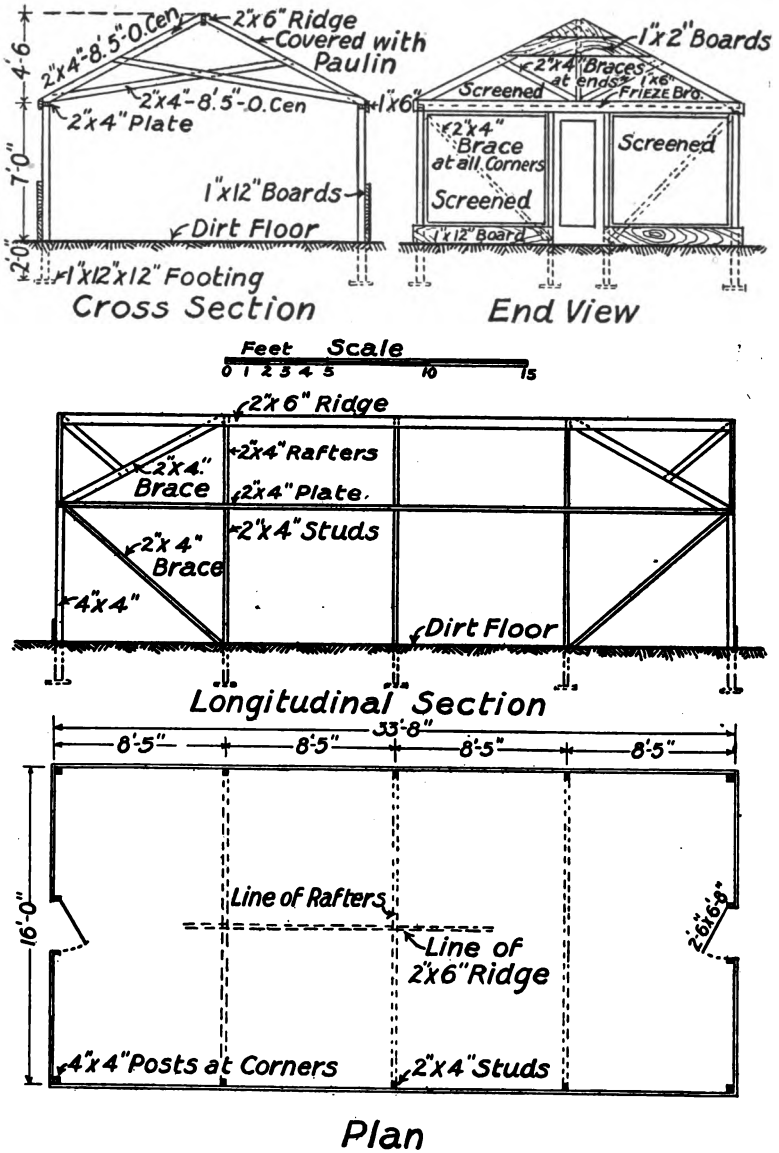


FIG. 131.—A two paulin kitchen and mess hall combined. (*Q. M. D.*)

BILL OF MATERIALS (FIG. 133)

Labor, carpenter, 8 hours
32 Pcs. 1″ × 12″ × 12′ 0″ = sides
1 Pc. 1″ × 4″ × 20′ 0″ = braces
11 Pcs. 2″ × 4″ × 12′ 0″ = plates and sills
1 Pc. 4″ × 4″ × 12′ 0″ = posts
5 Lb. 10d. wire nails.

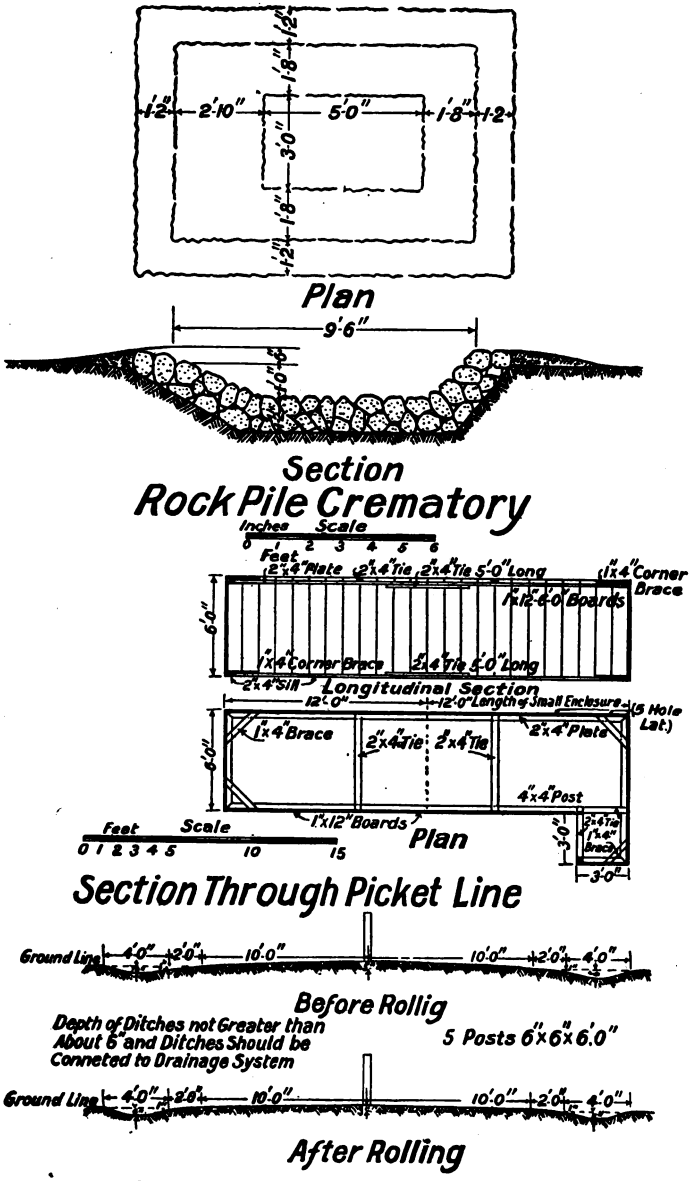


FIG. 133.—Latrine enclosure. (*Q. M. D.*)

BILL OF MATERIALS (FIG. 134)

3 Pcs. 2″ × 12″ × 16′ 0″ = sides and bottom—sized and dressed
1 Pc. 2″ × 12″ × 3′ 6″ = ends and center partition
6 Bolts ½″ × 16″
4 Lb. 20d. nails
Labor, carpenter, 4 hours

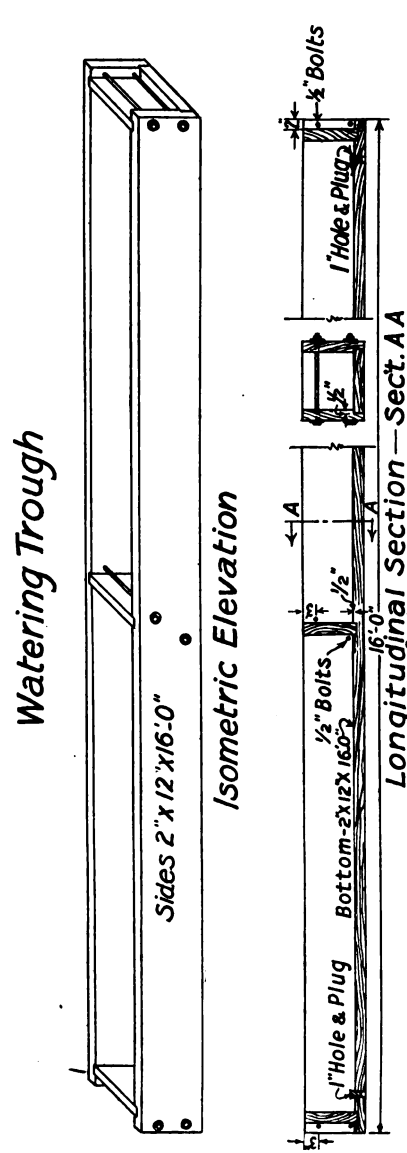


FIG. 134.—Watering trough. (Q. M. D.)

BILL OF MATERIALS (FIG. 135)

PYRAMIDAL, 16′ × 16′

Floor

9 Pcs. 2″ × 4″ × 16′ 0″
16 Pcs. 1″ × 12″ × 16′ 0″
5 Lb. 8d. nails.

Framing

1 Pc. 2″ × 4″ × 14′ 0″
5 Pcs. 2″ × 4″ × 16′ 0″
1 Pc. 1″ × 12″ × 14′ 0″
3 Pcs. 1″ × 12″ × 16′ 0″
3 Lb. 16d. nails.

WALL (SMALL)

8′ 11½″ × 9′ 2″

Floor

3 Pcs. 2″ × 4″ × 18′ 0″
4⅓ Pcs. 1″ × 12″ × 18′ 0″
2 Lb. 8d. nails.

Framing

1 Pc. 2″ × 4″ × 18′ 0″
2 Pcs. 2″ × 4″ × 12′ 0″
2 Pcs. 2″ × 4″ × 10′ 0″
1 Pc. 1″ × 12″ × 18′ 0′
2 Lb. 16d. nails.

WALL (LARGE)

14′ 6″ × 14′ 3″

Floor

8 Pcs. 2″ × 4″ × 14′ 0″
14 Pcs. 1″ × 12″ × 16′ 0″
4 Lb. 8d. nails.

Framing

4 Pcs. 2″ × 4″ × 20′ 0″
2 Pcs. 2″ × 4″ × 18′ 0″
3 Pcs. 2″ × 4″ × 16′ 0″
4 Pcs. 2″ × 4″ × 14′ 0″
2 Pcs. 1″ × 12″ × 16′ 0″
2 Pcs. 1″ × 6″ × 16′ 0″
4 Lb. 16d. nails.

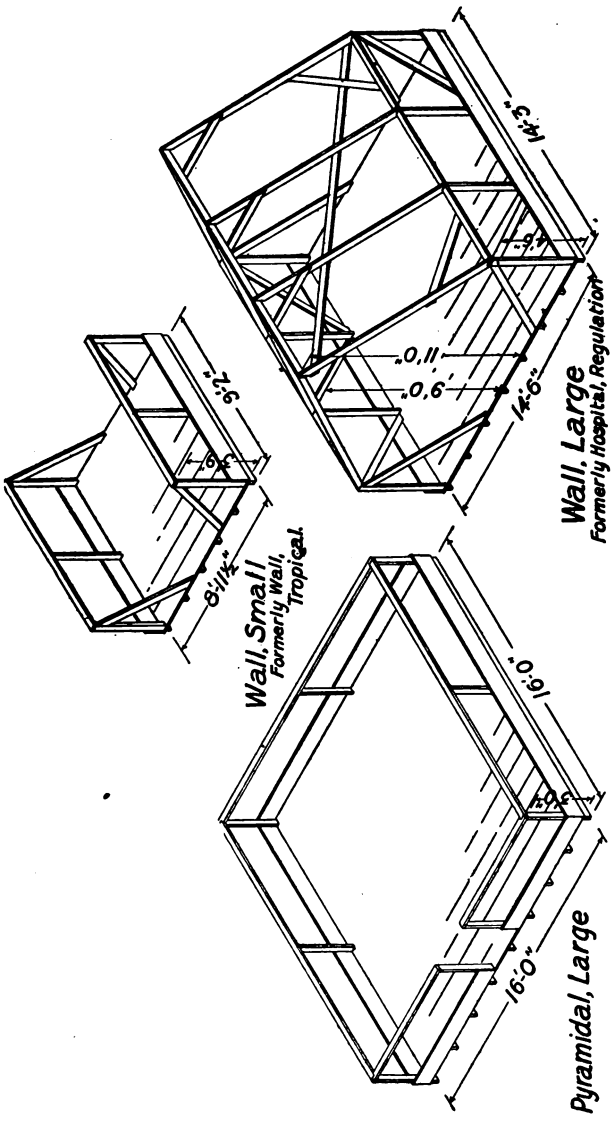

Wall, Small
Formerly Wall, Tropical
8'-11¼"
2'-6"
Wall, Large
Formerly Hospital, Regulation
14'-6"
14'-3"
Pyramidal, Large
16'-0"
16'-0"

FIG. 135. (Q. M D.)

BILL OF MATERIALS (FIG. 136)

HOSPITAL TROPICAL	STORAGE
15′ 7″ × 14′ 3″	20′ 5″ × 17′ 10″
Floor	**Floor**
9 Pcs. 2″ × 4″ × 14′ 0″	11 Pcs. 2″ × 4″ × 18′ 0″
14 Pcs. 1″ × 12″ × 16′ 0″	18 Pcs. 1″ × 12″ × 20′ 0″
4 Lb. 8d. nails.	7 Lb. 8d. nails.
Framing	**Framing**
4 Pcs. 2″ × 4″ × 14′ 0″	3 Pcs. 2″ × 4″ × 22′ 0″
4 Pcs. 2″ × 4″ × 10′ 0″	4 Pcs. 2″ × 4″ × 14′ 0″
2 Pcs. 2″ × 4″ × 16′ 0″	18 Pcs. 2″ × 4″ × 12′ 0″
2 Pcs. 1″ × 12″ × 16′ 0″	2 Pcs. 1″ × 12″ × 12′ 0″
3 Lb. 16d. nails.	2 Pcs. 1″ × 12″ × 10′ 0″
	9 Pcs. 1″ × 6″ × 14′ 0″
	6 Lb. 16d. nails.

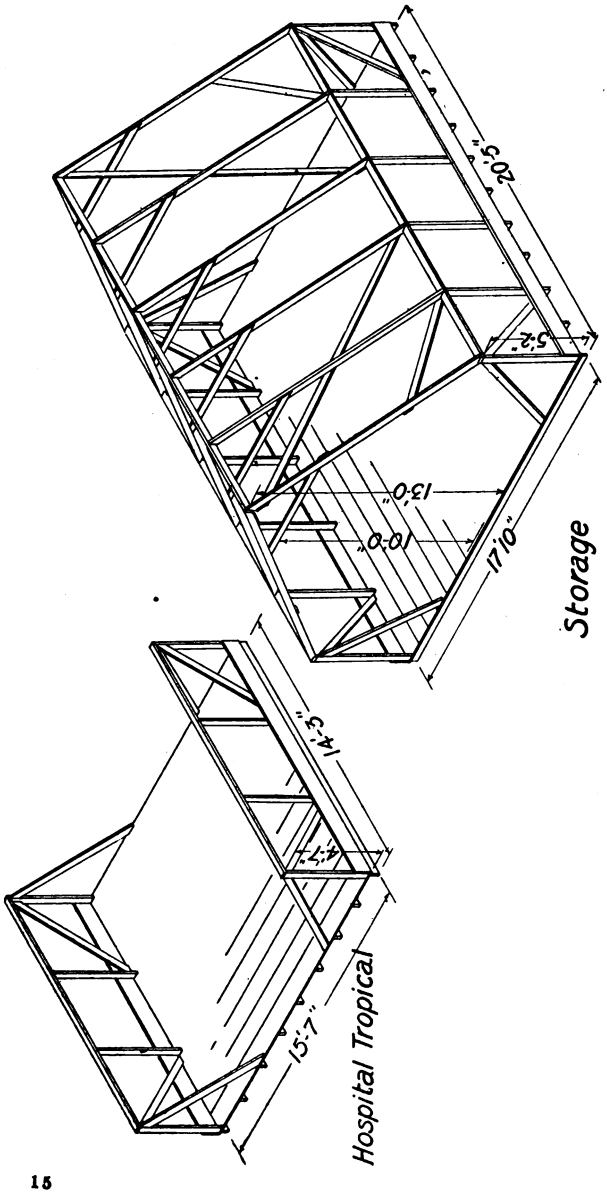


FIG. 136. (Q. M. D.)

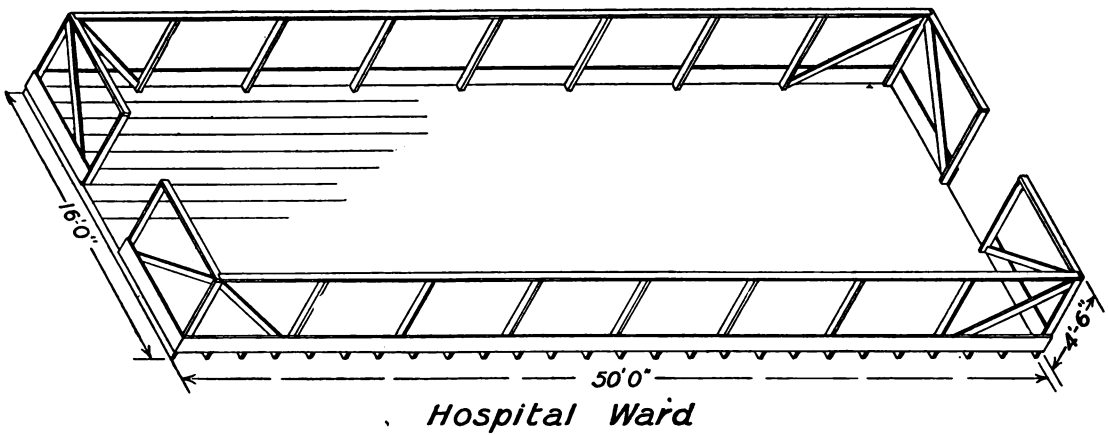


FIG. 137.—Hospital ward. (*Q. M. D.*)

BILL OF MATERIALS

Floor	Framing	
26 Pcs. 2″ × 4″ × 16′ 0″	4 Pcs. 2″ × 4″ × 12′ 0″	4 Pcs. 2″ × 4″ × 20′ 0″
48 Pcs. 1″ × 12″ × 12′ 0″	4 Pcs. 2″ × 4″ × 16′ 0″	8 Pcs. 1″ × 12″ × 12′ 0″
16 Pcs. 1″ × 12″ × 14′ 0″	5½ Pcs. 2″ × 4″ × 18′ 0″	2 Pcs. 1″ × 12″ × 14′ 0″
15 Lb. 8d. nails.	4 Lb. 16d. nails.	

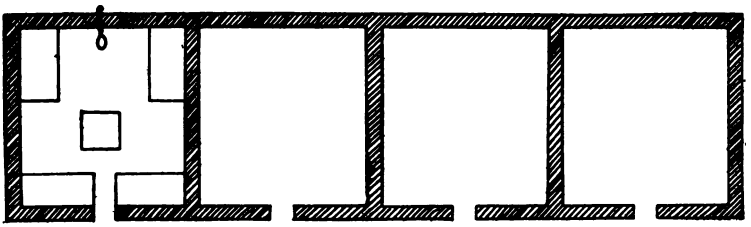


FIG. 138.—A set of improvised barracks. Ground plan. Scale $\frac{1}{16}'' = 1'$. (*Lake.*)

DIMENSIONS OF BUILDING
Length outside—59′ 9″
Width outside—17′ 6″
Height in front—7′
Height in rear—6′

DIMENSIONS OF SECTION
Length inside—16′
Width inside—14′
Height same as outside.

DOORS—5′ 6″ × 2′

WINDOWS—2′ × 1′ 6″

HOUSING CAPACITY
Four men per section
Sixteen men per building.

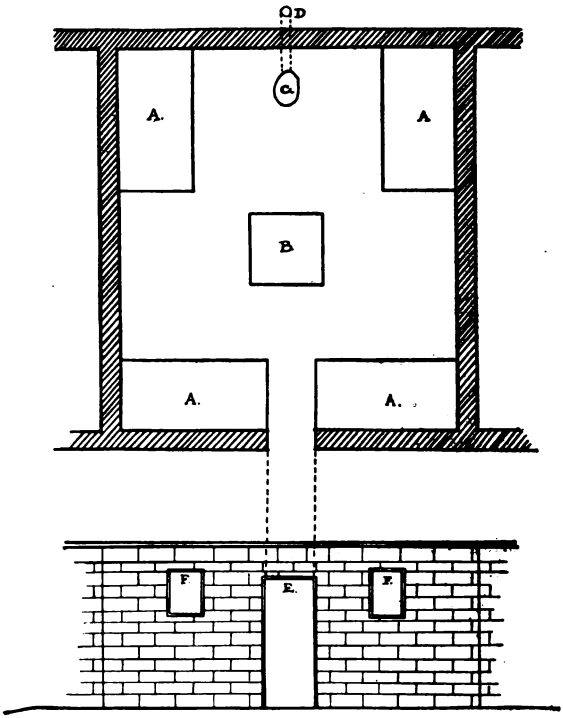


FIG. 139.—Section of improvised barracks. Front elevation. *A*, Bunks; *B*, table; *C*. stove; *D*, chimney; *E*, door; *F*, windows. Scale $\frac{1}{8}$" = 1'. (*Lake.*)

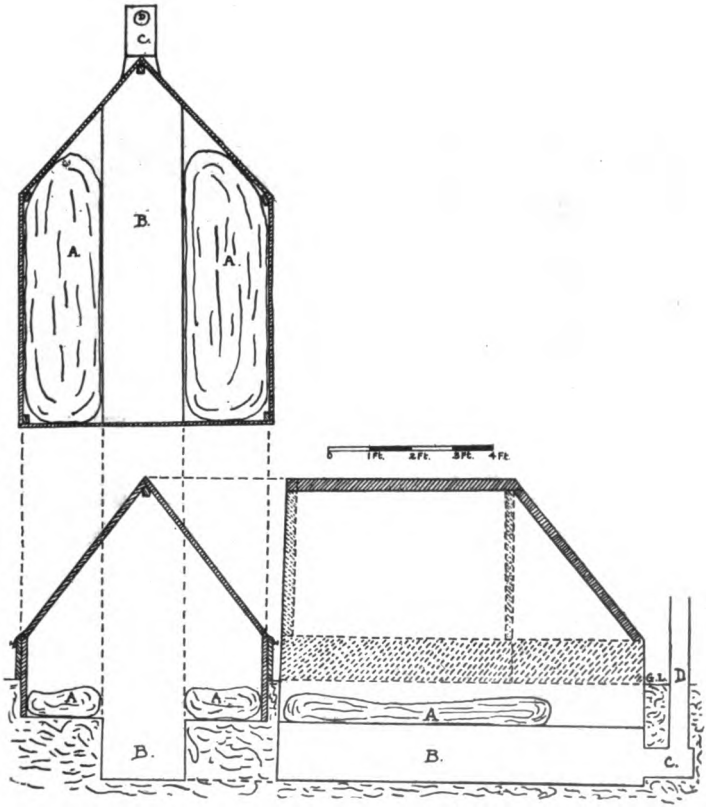


FIG. 140.—Dugout with shelter tent roof. *A*, Bunks; *B*, trench; *C*, stove; *D*, chimney. (*Lake.*)

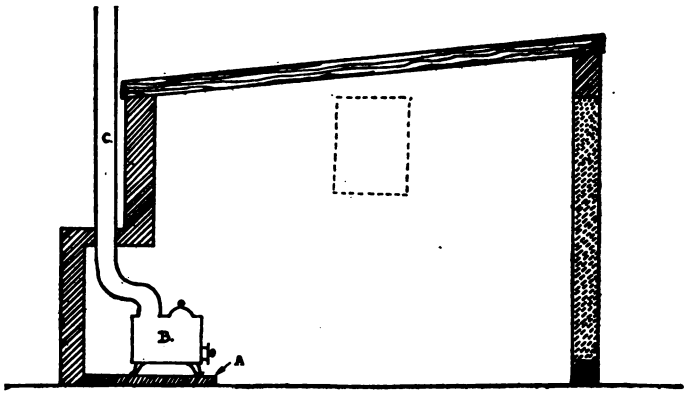


FIG. 141.—Section of officers' house (Fig. 143). (*Designed by Geo. B. Lake, M. C.*)

DIMENSIONS

	WINDOWS
Inside 9 × 9′	Two 18 × 24″
Height, front, 7′ clear	Two 14 × 18″
Height, rear, 6′ clear	

Scale $\frac{1}{4}$″ = 1′

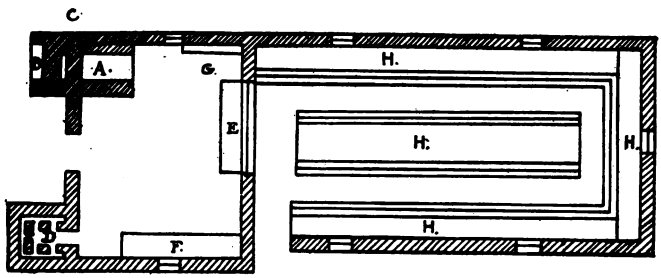


FIG. 142.—Combined kitchen and mess hall No. 2. Scale $\frac{1}{16}$" = 1'. *A*, Cook fire; *B*, incinerator; *C*, chimney; *D*, oven; *E*, serving table; *F*, shelves for supplies; *G*, rack for utensils; *H*, mess tables. (Doors and windows indicated.)

DIMENSIONS

Length, over all—47'
Kitchen—14 × 18'
Mess hall—16 × 33'
Side walls—6' high
End walls—2' pitch to ridge-pole
Doors—3 × 6'
Windows—2 × 2'

(*Designed by Sgt. Hagan, troop "D," 11th Cavalry.*)

The kitchen is roofed with a large tent-fly, and the mess hall with an 18 × 36' paulin.

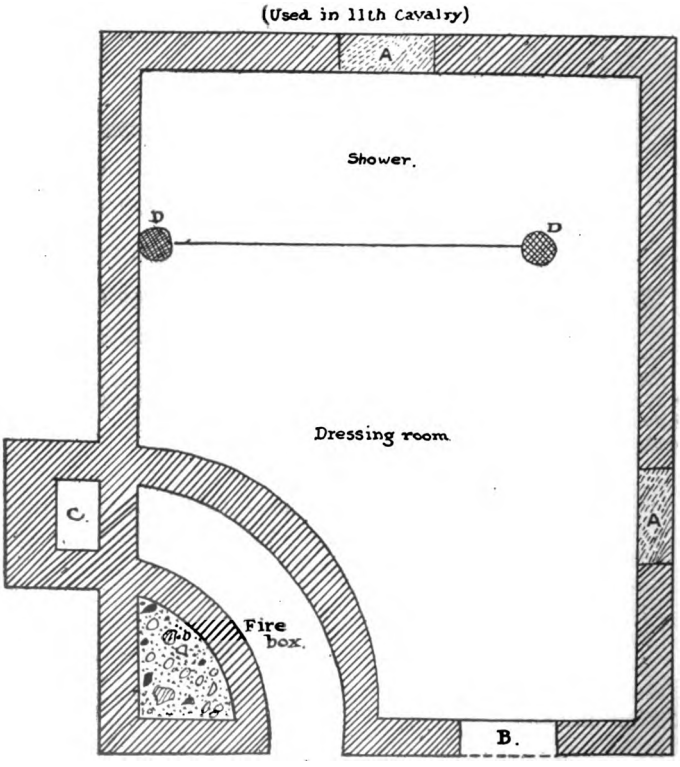


FIG 143.—Officers' bath house. *A*, Window; *B*, door; *C*, chimney; *D*, posts. Scale ¼" = 1'. (*Lake.*)

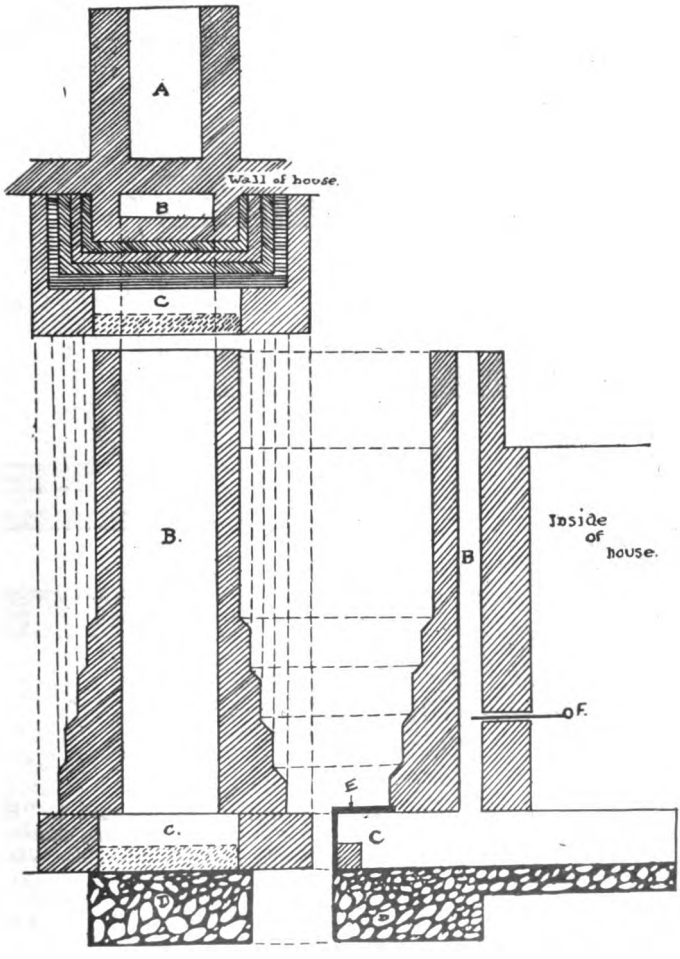


FIG. 144.—An effective cook fire and incinerator designed by Sgt. Margulas, troop "E" 11th Cavalry. *A*, Cook fire; *B*, chimney; *C*, incinerator; *D*, rock pit; *E*, sheet iron cover; *F*, damper. Scale ¼" = 1'. (*Lake.*)

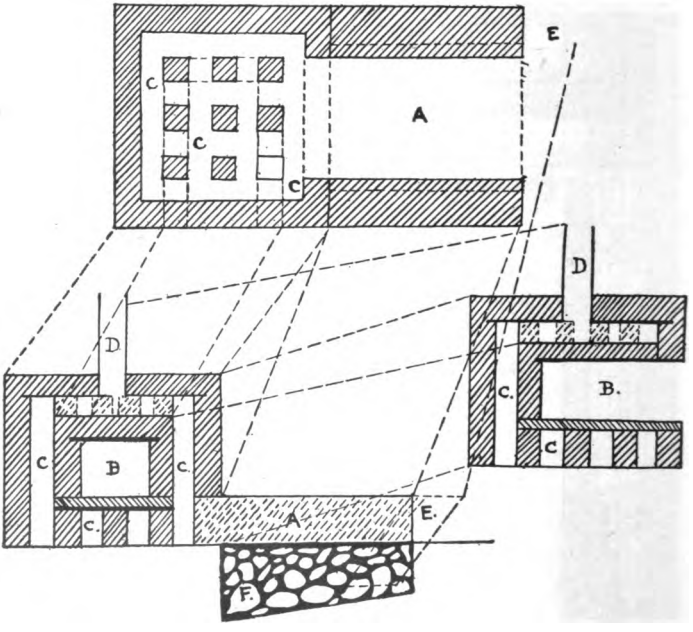


FIG. 145.—Combined oven, cook fire, and incinerator used in "E" Troop 11th Cavalry *A*, Cook fire and incinerator; *B*, baking chamber of oven; *C*, heat flues; *D*, chimney; *E*, slop chute; *F*, rock pit. Scale ¼" = 1'. (*Lake.*)

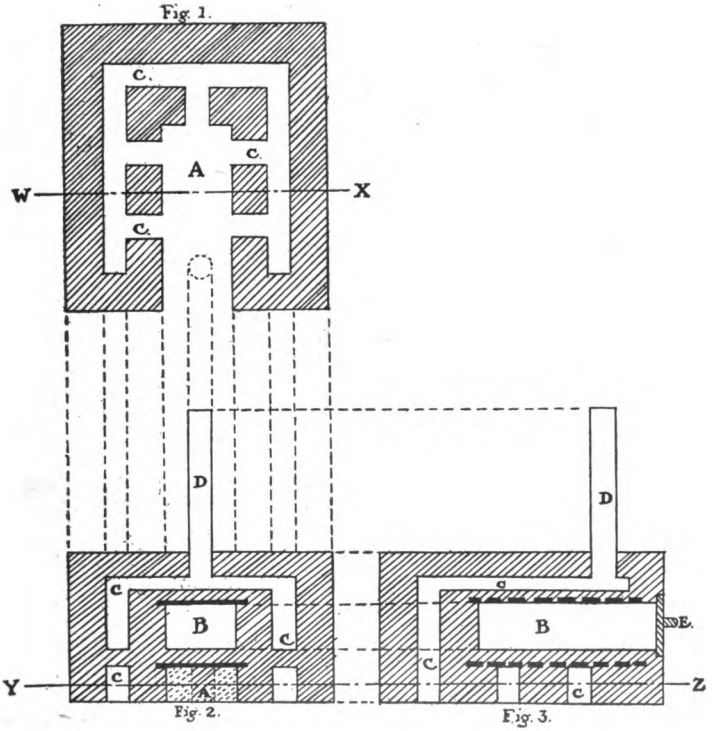


Fig. 146.—Improvised field oven materials: Adobe brick, discarded wagon tires and tin from gasoline cans. 1, Section on 2 and 3 at *YZ*; 2, section on 1 at *WX*. *A*, Fire box; *B*, oven; *C*, heat flues; *D*, chimney; *E*, ovendoor. Scale ¼″ = 1′. (*Lake.*)

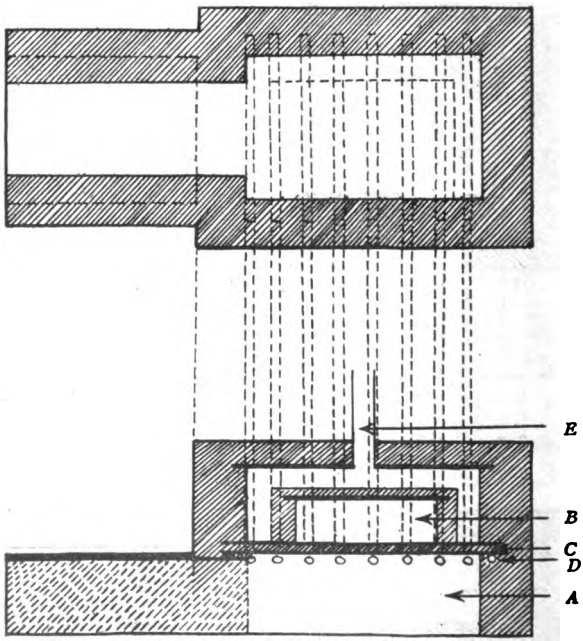


FIG. 147.—Oven and cook fire. (*Lake.*) *A*, Cook fire; *B*, interior of oven; *C*, heavy sheet-iron plate; *D*, sections of pipe supporting oven; *E*, chimney. Scale ¼″ = 1′.

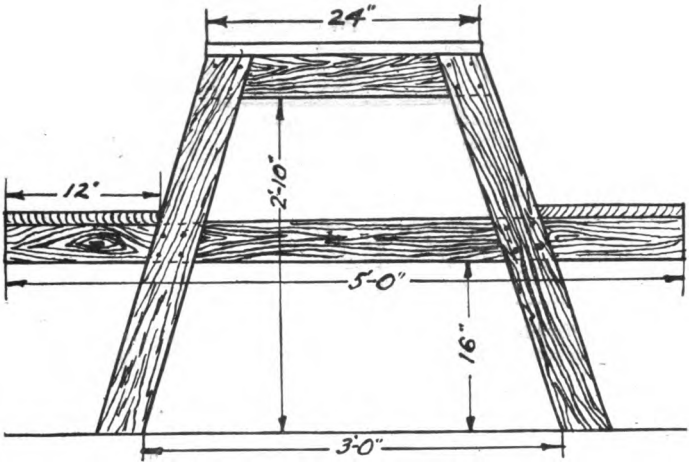


FIG. 148.—Common form of mess table. (*Lake.*)

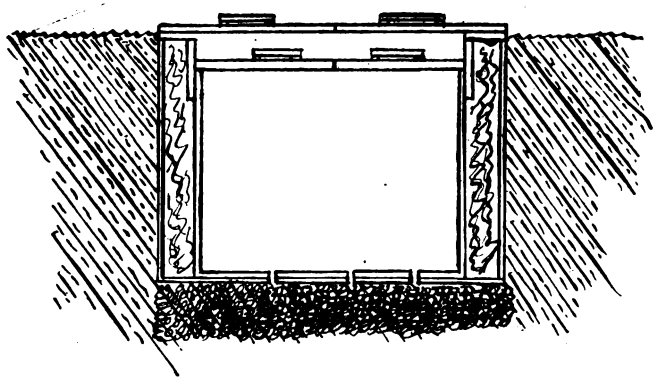


FIG. 149.—Subterranean ice box. (*Manual for Army Cooks.*) In hot climates this device is not advisable since the temperature of the earth is higher than that of the air. Another drawback is the difficulty of keeping it clean.

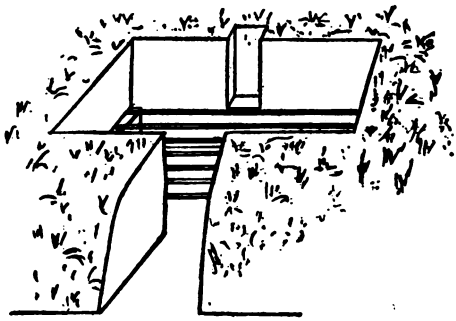


FIG. 150.—Incineration pit in hill side. If its top be covered with sheets of tin except at its chimney draught is increased. (*Tournade.*)

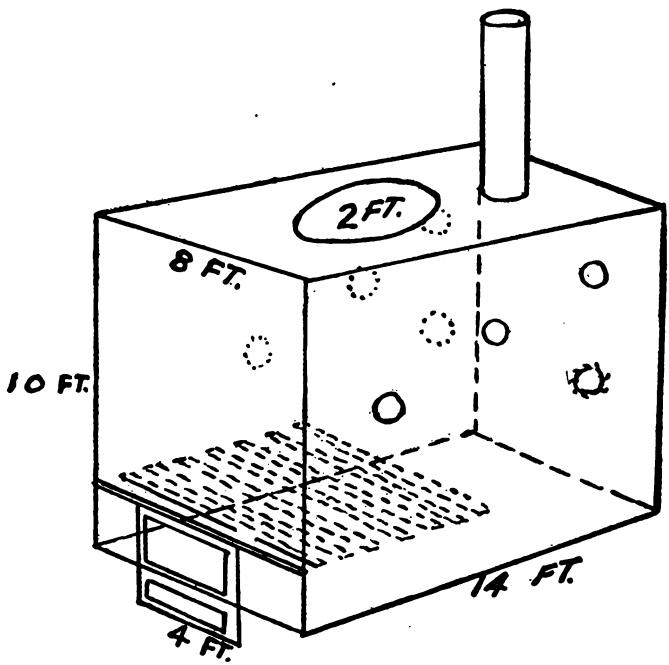


FIG. 151.—Manure incinerator.

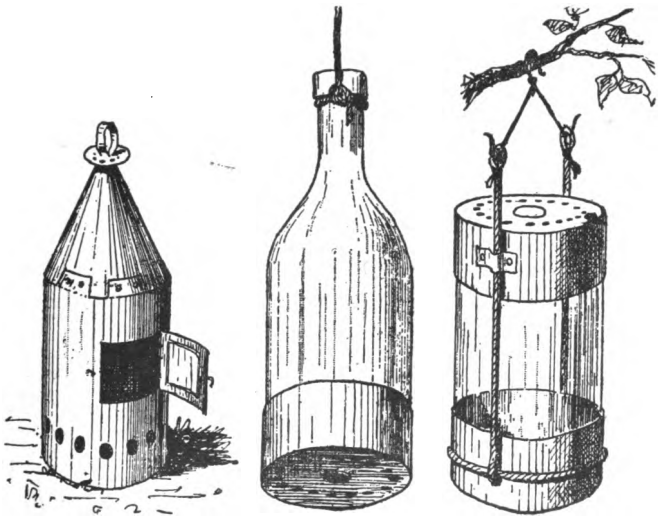


FIG. 152.—Improvised lanterns. (*Tournade.*)

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